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Nobel Prize in Physics, 1945

New Kilgore-Magnuson Bill

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SCIENCE

Vol. 103, No. 2669 — Friday, February 22, 1946

Remarks on the History of the Exclusion Principle

Wolfgang Pauli

Institute for Advanced Study, Princeton, New Jersey

THE HISTORY OF THE DISCOVERY of the exclusion principle, for which I have received the honor of the Nobel Prize award this year, s back to my student days in Munich. While, in ol in Vienna, I had already obtained some knowle of classical physics and the then-new Einstein tivity theory, it was at the University of Munich I was introduced by Sommerfeld to the structure he atom—somewhat strange from the point of v of classical physics. I was not spared the shock h every physicist accustomed to the classical way hinking experienced when he came to know of r's "Basic postulate of quantum theory" for the t time. At that time there were two approaches he difficult problems connected with the quantum ction. One was an effort to bring abstract order he new ideas by looking for a key to translate sical mechanics and electrodynamics into quantum uage which would form a logical generalization hese. This was the direction which was taken by r's Correspondence Principle. Sommerfeld, howr, tried to overcome the difficulties which blocked use of the concepts of kinematical models by a ct interpretation of the laws of spectra in terms ntegral numbers, following, as Kepler once did in investigation of the planetary system, an inner ing for harmony. Both methods, which did not ear to me irreconcilable, influenced me. The series hole numbers 2, 8, 18, 32 . . . , giving the lengths he periods in the natural system of chemical elets, was zealously discussed in Munich, including remark of the Swedish physicist, Rydberg, that e numbers are of the simple form $2n^2$ if "n" takes ll integer values. Sommerfeld tried especially to connect the number 8 and the number of corners of a cube.

A new phase of my scientific life began when I met Niels Bohr personally for the first time. This was in 1922, when he gave a series of guest lectures at Göttingen in which he reported on his theoretical investigations on the periodic system of elements. I shall recall only briefly that the essential progress made by Bohr's considerations at that time was in explaining by means of the spherically symmetric atomic model the formation of the intermediate shells of the atom, and the general properties of the rare earths. The question as to why all electrons for an atom in its ground state were not bound in the innermost shell had already been emphasized by Bohr as a fundamental problem in his earlier works. In his Göttingen lectures he treated particularly the closing of this innermost K shell in the helium atom and its essential connection with the two noncombining spectra of helium, the ortho- and parahelium spectra. However, no convincing explanation for this phenomenon could be given on the basis of classical mechanics. It made a strong impression on me that Bohr at that time and in later discussions was looking for a general explanation which should hold for the closing of every electron shell and in which the number 2 was considered to be as essential as 8 in contrast to Sommerfeld's approach.

During these meetings in Göttingen Bohr came to me one day, accompanied by his assistant, Oskar Klein (now professor in Stockholm), and asked me whether I could come to him in Copenhagen for a year. He needed a collaborator in the editing of his works, which he wanted to publish in German. I was much

Professor *Wolfgang Pauli* was honored for the award of the Nobel Prize in physics at a dinner on 10 December 1945 at the Institute for Advanced Study, Princeton. Dr. Frank Aydelotte, director of the Institute, welcomed the guests and called on Professor Hermann Weyl to offer a toast, which was seconded by Professor Albert Einstein and Erwin Panofsky. Professor Pauli then gave the principal address.

***Science* prints an amplified version of Professor Pauli's address together with somewhat shortened accounts of Dr. Aydelotte's introduction and Professor Weyl's encomium.**

surprised, and after considering a little while I answered with that certainty of which only a young man is capable: "I hardly think that the scientific demands which you will make on me will cause me any difficulty, but the learning of a foreign tongue like Danish far exceeds my abilities." The result was a hearty burst of laughter from Bohr and Klein, and I went to Copenhagen in the fall of 1922, where both of my contentions were shown to be wrong. The first words I learned were the integers. The way in which such simple numbers as 50, 70, and 90 are expressed in Danish—in a complicated fashion as half-multiples of 20—particularly impressed me, but I understood the idea and could easily recognize the words. But the half-integers used by Landé as magnetic quantum numbers to explain the anomalous Zeeman effect presented much greater difficulties for me. "Anomalous Zeeman effect" refers to a type of splitting of the spectral lines in a magnetic field which is different from the normal triplet. The anomalous type of splitting was on the one hand especially fruitful because it exhibited beautiful and simple laws, but on the other hand it was hardly understandable, since very general assumptions concerning the electron, using classical theory as well as quantum theory, always led to the simple triplet. A closer investigation of this problem left me with the feeling that it was even more unapproachable. A colleague who met me strolling rather aimlessly in the beautiful streets of Copenhagen said to me in a friendly manner, "You look very unhappy"; whereupon I answered fiercely, "How can one look happy when he is thinking about the anomalous Zeeman effect?" I could not find a satisfactory solution at that time, but succeeded, however, in generalizing Landé's analysis for the simpler case (in many respects) of very strong magnetic fields (*Z. Phys.*, 1923, **16**, 155). This early work was of decisive importance for the finding of the exclusion principle.

When in 1923 Bohr made his first trip to the United States, I returned, as an assistant, to the University of Hamburg, where soon afterwards I gave my inaugural lecture as *Privatdozent* on the periodic system of elements. The contents of this lecture appeared very unsatisfactory to me, since the problem of the closing of the electronic shells had been clarified no further. The only thing that was clear was that a closer relation of this problem to the theory of multiplet structure must exist. I therefore tried to examine again critically the simplest case, the doublet structure of the alkali spectra. I arrived at the result that the point of view then orthodox—according to which a finite angular momentum of the atomic core was the cause of this doublet structure—must be given up as incorrect. In the fall of 1924 I published some of my arguments (*Z. Phys.*, 1925, **31**, 373) that, instead of the angular momentum of the closed she[ll]s of the atomic core, a new quantum theoretic proper[ty] of the electron had to be introduced which I called [a] two-valuedness not describable classically." At t[hat] time a paper by the English physicist, Stoner, a[p]peared (*Phil. Mag.*, 1924, **48**, 719), containing n[ot] only improvements in the classification of electrons [in] subgroups, but also the essential remark that the nu[m]ber of energy levels of a single electron in the alk[ali] metal spectra for a given value of the principle qua[n]tum number in an external magnetic field is the sa[me] as the number of electrons in the closed shells of t[he] rare gases which corresponds to this principal qua[n]tum number. On the basis of my earlier results [on] the classification of spectral terms in a strong ma[g]netic field the general formulation of the exclusi[on] principle became clear to me. The fundamental id[ea] can be formulated in the following way: The comp[li]cated numbers of electrons in closed subgroups redu[ce] to the simple number *one* if the division of the grou[ps] by giving the values of the 4 quantum numbers of [an] electron is carried so far that every degeneracy is r[e]moved. A single electron already occupies an entire nondegenerate energy level. The exposition of th[e] general formulation of the exclusion principle w[as] made in Hamburg in the spring of 1925 (*Z. Phys.*, 1925, **31**, 765) after I was able to verify some add[i]tional conclusions during a visit to Tübingen, with t[he] help of the spectroscopic material assembled there.

If one pictures by boxes the nondegenerate stat[es] of an electron in an atom, the exclusion princip[le] maintains that a box can contain no more than o[ne] electron. This, for example, makes the atoms mu[ch] larger than if many electrons could be contained i[n] the innermost shell. Quantum theory maintains th[at] other particles such as photons or light particles sho[w] opposite behavior; that is, as many as possible fi[ll] the same box. One can call particles obeying th[e] exclusion principle the "antisocial" particles, whi[le] photons are "social." However, in both cases sociolo[gists] will envy the physicists on account of the sim[plifying] assumption that all particles of the sam[e] type are exactly alike.

With the exception of experts on the classificatio[n] of spectral terms, people found it difficult to under[stand] the exclusion principle, since no meaning i[n] terms of a model was given to the fourth degree o[f] freedom of the electron. The gap was filled by Uhlen[beck] and Goudsmit's idea of electron spin, whi[ch] made it possible to understand the anomalous Zeema[n] effect. Since that time the exclusion principle ha[s] been closely connected with the idea of spin. Al[though] at first I strongly doubted the correctness o[f] this idea because of its classical mechanical characte[r], I was finally converted to it by Thomas' calculation

on the magnitude of doublet splitting. On the other hand, my earlier doubts as well as the cautious expression, "classically nondescribable two-valuedness," experienced a certain verification during later developments, as Bohr was able to show on the basis of wave mechanics that the electron spin cannot be measured by classically describable experiments (as, for instance, deflection of molecular beams in external electromagnetic fields) and must therefore be considered as an essentially quantum mechanical property of the electron.[1]

This is not the place to go into the details of the subsequent developments. On the one hand, the validity of the exclusion principle for all elementary particles of spin ½ was shown (for example, not only for electrons but also for neutrons and protons). This gave the principle a more general and universal meaning, and it found application to the problem, still not completely solved, of nuclear structure. On the other hand, the exclusion principle could not be deduced from the new quantum mechanics and wave mechanics, but remains an independent principle which excludes a class of mathematically possible solutions of the wave equation. This excess of mathematical possibilities of the present-day theory, as compared with reality, is in my opinion one of several indications that in the region where it touches on relativity theory, quantum theory has not yet found its final form.

The history of the exclusion principle is thus already an old one, but its conclusion has not yet been written. The essential advance of physics rests on the creative imagination of the experimental as well as the theoretical investigator, and, contrary to expensive applications of known principles, cannot be forced by planning on a grand scale. Therefore it is not possible to say beforehand where and when one can expect the further development of the basic principles of present-day physics, of which the problem of the exclusion principle is a part. We know, however, that this further development can take place only in the same atmosphere of free investigation and unhampered exchange of scientific results between nations that existed at the time of the disclosure of the exclusion principle. I am therefore very glad to be able to give this short historical survey here in Princeton's Institute for Advanced Study, which in the difficult years of the war, by support of pure and free research irrespective of applications, made it possible for me and others to continue our scientific work.

[1] See Rapport du Sixieme Conseil Solvey de Physique, Paris, 1932, pp. 217–225.

Introductory Remarks

Frank Aydelotte, *Director*
Institute for Advanced Study, Princeton, New Jersey

IT GIVES ME GREAT PLEASURE, ladies and gentlemen, to welcome you on behalf of the Trustees and Faculty of the Institute for Advanced Study on this happy occasion. The awarding of a Nobel Prize to a newly appointed member of our Faculty is just the kind of endorsement of our choice that we value and that we ought to expect. In one sense Pauli's is our fourth Nobel Prize: one member of our Faculty, Einstein; one former member of our Board of Trustees, Carrel; and one former member of the Institute, Rabi, have already received Nobel Prizes. That, however, is a little like the statement in the Believe-It-or-Not cartoon that Lindberg was the sixty-fourth person to fly across the Atlantic ocean. In a real sense Pauli is our first, just as Lindberg was the first to succeed in the design which he attempted.

About one-seventh of the 215 Nobel Prizes so far awarded have gone to citizens of the United States. In view of the size of our educational organization, that is not too many—indeed, it is not enough. We cannot yet claim Pauli's as an American achievement; the exclusion principle was formulated by him twenty years ago while he was still an Austrian. We hope that in a few weeks we shall have the pleasure of welcoming Dr. and Mrs. Pauli to American citizenship.

It is fitting that Pauli should become an American citizen and a member of the Faculty of the Institute for Advanced Study. American civilization, American scholarship, American art and letters, are products of the great European tradition. Our task is not to separate ourselves from that tradition but to support it and to enrich it by the productive work of American scholars. In these days when all men's minds in every field of endeavor are disturbed by the conflict between individualism and collectivism, we may be thankful for the fact that our scholarly tradition is one of individualism. The Nobel Prizes are one evidence of that philosophy. The organization of the Institute for Advanced Study is another. The fundamental plan of this institution is to provide opportunity for individual effort, not for what is called planned research. Our newspapers and magazines,

even some scientific periodicals, are filled today with vast and nebulous schemes for the regimentation of scholars in the great war against chaos and ignorance. Useful work, like the production of the atomic bomb (if you call that useful), may be done by such organization. But the great advances of knowledge are not made by such means. They are, rather, the product of individual effort, free, unpredictable in their nature and in their consequences. They are the products of minds like Newton, Einstein and Pauli: "Voyaging through strange seas of thought alone."

Such a plan or, rather, lack of plan for the advancement of knowledge violates all the instincts and preconceptions of the adminstrative type of mind. It is not orderly, but, rather, haphazard. I can only say that the whole process of evolution on this planet has, so far as we can see, been an unexpected one. It may conform to some divine plan, but it does not follow any plan of human devising. There is nothing in the *Bible* about the exclusion principle or the atomic bomb, though the author of "Revelations" would doubtless have equipped the Four Horsemen of the Apocalypse with the latter device had he known about it.

Robert Louis Stevenson was once asked what was the moral to one of his stories. "My moral?" he replied, "I have no moral: it is God's moral that I am trying to understand." So with our scientists. It is nothing less than the mind of God they are seeking to penetrate.

All educational institutions, all societies of scholars, are devoted to this high quest. It is with this in mind that we have tried to make conditions here such that they can devote themselves to it in the single-minded way that is not always possible elsewhere. It is in line with our fundamental purpose that we have chosen Pauli to be a member of our Faculty. We hope that he will make his career here and that the exclusion principle will not be the last or the greatest of his contributions to physics.

Encomium

Hermann Weyl
Institute for Advanced Study, Princeton, New Jersey

IT IS DIFFICULT TO IMAGINE what the history of physics would have been without the influence of Pauli during the last twenty-odd years. As another Nobel laureate recently expressed it, "Pauli for many years has been the conscience and criterion of truth for a large part of the community of theoretical physicists." Thus, there is complete unanimity the world over that Pauli has amply deserved the recognition now accorded his work by the Royal Swedish Academy, to whose hands, by Nobel's will, the distribution of the Nobel Prize for Physics is entrusted. . . .

I think it is very fortunate that through the accident of Nobel's birth the lot to bestow this highest international honor for scientific achievement fell to Sweden, one of the Scandinavian countries. Indeed, these countries march in the vanguard of civilization; nowhere on this planet has man come nearer to the fulfillment of his dream of a happy and free life, with justice and equal opportunity for all, where good prevails over evil, and beauty and truth can shine and are loved. In physics and mathematics in particular the Scandinavian countries have, during the last decades, contributed more than their share to the advancement of our knowledge. It is enough to mention one name, that of Niels Bohr, who has exerted the most extraordinary influence upon the development of physics and on the whole generation of younger physicists in the last thirty years. Pauli himself is his disciple.

The impression prevails that it has been harder for a theoretical than for an experimental physicist to win the Nobel laurels. One obvious reason is that it is more difficult to assess at an early stage the importance of a theoretical discovery. When modern quantum physics came into being around 1925, one often spoke of it as boys' physics—"Knabenphysik." Indeed, at the time neither Heisenberg, nor Dirac, nor Pauli were over twenty-five (de Broglie and Schrödinger were somewhat older). It is gratifying that now all the boys who enacted this great scientific drama have been crowned by the Swedish Academy.

Born and educated in Vienna, Wolfgang Pauli started his scientific career in Munich under Arnold Sommerfeld. Perhaps I am among the first with whom he established scientific contacts, for the first papers he published dealt with a unified field theory of gravitation and electromagnetism which I had propounded in 1918. He dealt with it in a truly Paulinean fashion—namely, he dealt it a pernicious blow. Pauli's article on relativity theory, written in these years for the *Mathematical Encyclopaedia*, is a mature and masterly work which shows the author in full command of both the mathematical and physi-

cal aspects of the subject; and yet it was the work of a young man of twenty. After having earned his Ph.D. in Munich, Pauli migrated to Göttingen, since the time of Gauss a center of mathematical and physical research, where Max Born and James Franck were teaching at that time, and from there he went to Copenhagen and came under Niels Bohr's strong formative influence. From 1923 to 1928 he was *Dozent* at the University of Hamburg, and since then he has occupied a chair for theoretical physics at the Eidgenössische Technische Hochschule at Zürich. The year 1935–1936 he spent as a visiting professor at our Institute. In 1940, immediately after the invasion of Denmark and Norway by the Nazis, when it was clear that all the other neutral European countries were in danger of being overrun by the swastika, the Institute made an effort to bring Niels Bohr and Pauli to this country. Bohr considered it his patriotic duty to stay in Copenhagen, but we were lucky enough to get Pauli. I hope he does not regret that he came, even though Switzerland was spared the fate of being invaded by Hitler's hordes.

Let me now cast a quick glance over Pauli's principal achievements in physics—although a mathematician is hardly entitled to speak about them with authority. We mathematicians feel near to Pauli since he is distinguished among physicists by his highly developed organ for mathematics. Even so, he is a physicist; for he has to a high degree what makes the physicist: the genuine interest in the experimental facts in all their puzzling complexity. His accurate, instinctive estimate of the relative weight of relevant experimental facts has been an unfailing guide for him in his theoretical investigations. Pauli combines in an exemplary way physical insight and mathematical skill.

As I have already mentioned, Pauli began his work in the sign of relativity theory. Although he later returned to this theory on one or two occasions, his main work, by which he should be judged as a creative physicist, is in quantum physics. Here it is natural to distinguish the periods before and after the Heisenberg-Schrödinger break-through to a consistent quantum theory of the atom in 1925. In the time before this dramatic event one had to operate with Niels Bohr's models and a compromise that Bohr vaguely formulated as the Principle of Correspondence, and to find one's way through the maze of spectroscopic facts more by divination ("Schnauze" is Pauli's word for it) than by theory. It is remarkable that in this period Pauli scored some of his greatest successes. For instance, he saw that the so-called hyperfine structure of spectral lines is to be ascribed to a quantum character of the nucleus rather than to the electronic shell of the atom. But above all, his investigations concerning the Zeeman effect gradually led him to the discovery of the exclusion principle, according to which no two electrons may be in the same quantum state. This was a very bold conception. The exclusion principle, strange and incomprehensible as it is from the standpoint of classical physics, is decisive for an understanding of the periodic system of chemical elements. It is a lasting achievement, which will hardly be affected by any future changes of our physical theories.

One would expect that in stable equilibrium each electron revolving around the nucleus occupies the lowest possible energy level, according to the Planck-Bohr quantum rule. Instead, when we run over the chemical elements in their natural order, we find that only the first two electrons, in hydrogen and helium, are bound in this lowest state. Then a sort of saturation seems to be reached. The next element, lithium, has only one valence electron. As the spectra show, the eight electrons from lithium to neon are all bound in the next higher level, and with neon again a closed shell which can admit no further electrons, seems to have been completed. It is these fundamental facts which Pauli's exclusion principle explains. In developing it he had to overcome an accessory difficulty. When he started his work the quantum state of an electron was characterized by three quantum numbers. But that led to shells of 1, 4, 9 . . . electrons instead of 2, 8, 18 . . . , as we find in nature. He accounted for this "duplicity" by a fourth quantum number of the electron. Shortly afterward, Goudsmit and Uhlenbeck suggested that this quantum number had its origin in an angular momentum, a spin of the electron. Again it was Pauli who, once the foundations of the new quantum mechanics were established, first succeeded in describing correctly the nature of this momentum, which is radically different from that of a spinning top and not to be accounted for by classical concepts.

The Pauli principle reveals a general mysterious property of the electron, the importance of which is by no means limited to spectroscopy. Pauli himself applied it to the statistics of particles in a degenerate gas, thus explaining the paramagnetic properties of such gases. A paper on the paramagnetism of metals laid the foundations for the quantum mechanical theory of electrons in metals. A step of great consequences, for which Dirac's quantum theory of radiation had paved the way, was taken in a joint investigation by Pauli and Heisenberg on the quantization of the field equations: thereby wave mechanics passed from the theory of a single particle to that of the interaction of an indefinite number of particles. Pauli's studies of the intimate relationship between

spin and statistical behavior of particles naturally led him to investigate the dynamics of the meson. The meson is now a generally accepted particle in nuclear physics. Of a more dubious character seems an invention of Pauli's, the most elusive of all elementary particles, which he dubbed neutrino, and others call Paulino. It is a particle without charge and mass, which nevertheless seems to be indispensable if the laws of conservation of energy and angular momentum are to be safeguarded. Here are question marks for the future.

My brief account is far from complete. I have not mentioned Pauli's two great articles on quantum theory, written for the *Handbuch der Physik* in 1925 and 1933. Enormous, but difficult to assess, is the influence Pauli has exerted by correspondence and discussion. In view of the discontinuous leaps by which theoretical physics develops, the stream of his scientific production has been remarkably steady. Indeed, when I compare the theoretical physicist with the mathematician I find that the former has a much harder lot. If the mathematician cannot solve a problem, he modifies it until he can solve it; no impenetrable reality limits the freedom of his imagination. So he is liable to succumb to Peer Gynt's temptation: " 'Go around,' said the crooked." Not so the physicist. He has to face the hard facts of nature. The problem of the atom must be solved straightforwardly; otherwise, no further progress is possible. Therefore, theorectical physics has affluent periods when, after persistent efforts, a new stage of theoretical interpretation has been reached, as was the case, for instance, in 1925; then there is all of a sudden plenty of highly satisfactory work for the theorist. But this alternates with stagnant periods where nothing else seems possible than to wait patiently for the slow accumulation of new facts by the experimentalists—facts which refuse to fall into any recognizable theoretical pattern. I have the greatest admiration for the courage and ingenuity with which Pauli has met this intriguing situation.

Another tension tells on the theoretical physicist—that between pure science and applications. He is a theorist and thereby committed to the contemplative life and its ideals. As Dilthey once said, "das vom Eigenleben unabhängige Glück des Sehens" is one of the most primitive and basic blessings of our existence. True, the physicist's contemplation is not a purely passive attitude—it is creative construction, but construction in symbols, resembling the creative work of the musician. On the other hand, science, since it discloses reality, is applicable to reality. Thus it is called upon to serve for the benefit and malefit of mankind. Its technical applications are used to make man's life more comfortable and more miserable, to build and to destroy. To what extent shall and can the theorist take responsibility for the practical consequences of his discoveries? What a beautiful theoretical edifice is quantum physics—and what a terrible thing is the atomic bomb! When they helped to develop the latter, did the physicists do nothing but their duty as citizens of a country engaged in total war, or did they prostitute their science? I think the experience of the last years has shown that there is little danger that the call of national duty will not be heeded by the scientists when the life of the nation is at stake, but that there is great danger indeed that in the fight for the basic values of our existence we may lose these values themselves; that the relentless pursuit of science—strange antinomy!—may imperil its very foundations in man's life. Pauli has all his life been deeply interested in philosophy. The wisdom of the Chinese sages seems to have a special appeal for him. No wonder that his sympathies are with those who are not willing to sacrifice the spiritual for the secular, and who are not willing to accept efficiency as the ultimate criterion. . . .

Scanning Science—

New honors are being bestowed upon the discoverers of argon. First came the Barnard gold medal of Columbia College, then the $10,000 Hodgkins prize, then the prize of 50,000 francs from the French Institute and now it is announced that Lord Rayleigh and Professor Ramsay have been made Knights of the Legion of Honor, by order of the French Government.

—14 February 1896

Technical Papers

e High Ascorbic Acid Content of e West Indian Cherry

NRADO F. ASENJO and ANA ROSA FREIRE DE GUZMÁN

ool of Tropical Medicine, San Juan, Puerto Rico

The West Indian cherry (*Malpighia punicifolia* L.), mmonly called "acerola" in Spanish, is a small tree ive to tropical and subtropical America. Its fruit fleshy and drupaceous, bright red in color when e, and possessing an agreeably acid taste. Each the cherries weighs about 5 grams; nearly 80 per t of their weight is edible.

As far as we have been able to find out, the three hest natural sources of ascorbic acid known to date the rose hips (*Rosa* sp.) (*4*), the "mirobalán" hylanthus emblica L.) (*3*), and the guava (*Psidium ajava* L.) (*5*). They contain about 1,700, 800, and mg., respectively, of ascorbic acid per 100 grams edible matter.

Utilizing the assay method of Bessey and King (*2*) 6-dichlorophenol indophenol titration), we found t the West Indian cherry contained within the high its of 1,000–3,300 mg. of ascorbic acid per 100 ms of edible matter. The variation in its ascorbic d content seems due principally to its degree of peness, the content being highest in the green fruit d lowest in the ripe.

TABLE 1

Degree of ripeness and color of fruit	No. of samples*	pH of juice	Range mg. ascorbic acid per 100 gram of edible matter	Average mg. ascorbic acid per 100 gram of edible matter
Unripe—green ...	4	3.35	2,516–3,309	2,963
Medium ripe—yellow green with red spots	3	3.35	2,481–3,048	2,787
Fully ripe—red ..	4	3.35	1,030–2,700	1,707

* Each sample consisted of at least 15 cherries.

To confirm fully the presence of ascorbic acid in the West Indian cherry, the acid was isolated from the juice by a method not materially different from that utilized by Banga and Szent-Gyorgyi (*1*) in their study of peppers. Briefly, it is as follows: The ascorbic acid is precipitated from the juice in the form of the lead salt on the addition of neutral lead acetate, followed by enough ammonium hydroxide to bring the pH to 8.3–8.5. The lead salt thus obtained is decomposed with concentrated HCl, the supernatant acid mixture then concentrated *in vacuo,* and the ascorbic acid, present therein, extracted with acetone. The acetone extracts are mixed wih *n*-butyl alcohol, and the acetone is evaporated *in vacuo.* Ascorbic acid remains in the *n*-butyl alcohol and crystallizes out of it, after standing at a temperature of 0° C. for three days.

A gram and a half of pure crystals was obtained out of 275 ml. of the juice. These crystals had a melting point of 191–192° C.; a mix melting point with synthetic *l*-ascorbic acid, 189–191° C. Equal weights of the synthetic and natural product decolorized, to the same extent, equal volumes of indophenol reagent. The specific rotation in water of the synthetic and the natural substances was also similar. It is quite apparent that the substance obtained from these cherries is pure *l*-ascorbic acid.

It would seem that the West Indian cherry is one of the richest, if not *the* richest, edible fruit source of ascorbic acid so far described in the literature.

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Motherless Males From Irradiated Eggs[1]

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"Androgenesis" (*6*) was first demonstrated by Hertwig (*3*), who found that, when amphibian eggs are heavily irradiated and then fertilized by untreated sperm, abnormality in development is *inversely* proportional to intensity of treatment. Embryos from such eggs have nuclei smaller than normal, and these nuclei were thought to be haploid and descendants of the sperm nucleus. Packard (*4*) irradiated Chaetopterus eggs in first meiotic metaphase and obtained clear cytological proof that the untreated sperm nucleus in such eggs can form the first cleavage figure and its successors. Dalcq (*1*) checked Hertwig's results and added cytological proof of androgenesis in Amphibia.

It is uncertain whether androgenetic larvae in any of these experiments would develop into adults. As

[1] Aided by a grant from the Rockefeller Foundation.

Fankhauser (*2*) has pointed out, "In the thousands of experiments which have been performed up to the present time, not a single haploid animal has been raised to a stage approaching sexual maturity." He is referring, of course, to animals in which all individuals are normally diploid. Normal, mature, androgenetic haploids might be expected to occur in species with haploid males, such as bees or wasps. During many years of intensive breeding of the parasitic wasp *Habrobracon juglandis,* several hundred mosaic individuals have been found among which 11 only (*5*) have had regions which were unquestionably paternal in origin. Among the progeny from crosses of dominant females by recessive males (condition in which androgenetic males can be identified) only five males have been reported showing genetic traits exclusively paternal with no traces of mosaicism. None of these was given a breeding test. A sixth, with "glass" eyes, bred as "glass," showing the gonads to be derived from the sperm nucleus. Thirteen of these 17 individuals were produced by females of one stock, and none was found in crosses from the stocks used in this experiment. Spontaneous androgenesis is, therefore, very rare, even in a species with normal male haploidy.

In a recent experiment, unmated females of an inbred wild type stock of Habrobracon were heavily X-rayed,[2] then mated to untreated males with recessive mutant traits. The surviving progeny (from eggs treated in first meiotic prophase) included among the expected wild type males (haploid and maternal) and females (diploid and biparental) a few males normal in structure and behavior and with the recessive mutant traits (haploid and paternal). Breeding tests demonstrated that their gonads were also paternal in origin, and the use of body color differences helped to show that they were not mosaic. Their normal fertility was proof of their haploidy, since diploid males in this species are almost completely sterile. Table 1 summarizes the results.

The cytological phenomena underlying the production of these motherless males remain to be investigated. Two possibilities suggest themselves: (1) The irradiated maternal chromosomes may be retarded in movement and fail to reach the male pronucleus in time for first cleavage or, having reached it, are soon eliminated so that the haploid paternal chromosome complement forms the embryo. The observations of Packard and of Dalcq demonstrate this type of behavior. (2) The fusion nucleus may fail to function, hampered by its irradiated chromatin, and, when dispermy occurs, the free sperm may form the embryo.

In egg X-rayed with lethal dose (*ca.* 45,000 r) and allowed to develop parthenogenetically, about 1.1 per cent die at first cleavage, while the remainder develo well beyond this stage, often to blastoderm. In nor mal eggs about 1 per cent show dispermy. Either these facts would seem to limit the production androgenetic males to about 1 per cent, but surviv percentages may not be dependable criteria of mod of origin because of differential viability.

[2] By L. R. Hyde at the Marine Biological Laboratory, Woods Hole, Massachusetts.

TABLE 1

Dose in r units	Number females treated	Progeny			
		Wild type males	Wild type females	Recessive males	Per cent andro-genesis
28,000	378	82	341	15	4.21
29,300	43	8	10	3	23.07
42,000	202	1	7	1	12.50
Controls ..	17	160	467	0	0.0

The production of these normal, sexually matu individuals from the sperm nucleus is of theoretic interest from two aspects. It adds evidence to a co cept which now seems to need little—that heredita traits are carried by the nucleus—and appears strengthen the point of view that X-ray injury, least up to lethal dose, is directly chromosomal, sin untreated chromosomes can function normally in t heavily treated cytoplasm of an egg whose own chr mosomes are so seriously injured as to be unable function.

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Diabetes Produced by Feeding Alloxan to Cats[1]

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It is well established that diabetes may be experi mentally induced in animals by *injection* of an appro priate amount of alloxan solution intravenously, in traperitoneally, intramuscularly, or subcutaneously In studying the introduction of alloxan into the ali mentary canal without subjecting the animal to th effect of an anesthetic or an operative procedure, we have discovered that diabetes can be produced by *feeding* alloxan to cats. Furthermore, in addition to the destructive effect on the beta cells of the pancreas, we have noticed injury to the adrenal cortex, the an terior lobe of the pituitary, the liver, and the kidneys.

Method. One part of alloxan was freshly mixed

[1] The authors wish to express their gratitude to Sidney M. Bergman for his interest in this work.

ith five parts of a favorite food and offered to a cat at had fasted 24 hours. If it did not eat promptly, e food was taken away and the procedure repeated 2 or 24 hours later. Animals that would not eat at at time were not used for these experiments. It is sential that they eat all of the dose quickly (in about or 10 minutes), since, if the food is eaten too slowly, e alloxan is diluted to below its cytotoxic level.

The dose varied from 0.5 to 1.0 gram/kg. and was gher for immature animals than for mature ones. ix to 12 hours after the alloxan meal, the animals ere given milk, and the next day they were fed their sual diet of milk and fresh raw meat.

Results. Of the 14 cats that ate the food mixed ith alloxan, two ate it too slowly, and one vomited me of the food. These three did not attain a diatogenic concentration of alloxan and seemed unrmed by their experience. A fourth cat developed complete anuria and died at the end of 72 hours.

The 10 cats that developed diabetes showed a arked albuminuria on the first day and had both lbumin and sugar in the urine on the second day. some animals the urine passed during the first 24 urs was of a bright red color, due to the excretion murexide. Four of these cats showed upper respitory irritation with sneezing and frothy mucus at e external nares. One had conjunctivitis, and one d blood in the stool on the sixth and seventh days.

The experiments were terminated to permit blood d tissue studies: 2 cats on the third day; 3 on the ghth day; and 1 each on the sixteenth, nineteenth, enty-first, thirty-sixth, and sixty-fourth days. The erage blood sugar of the five animals sacrificed on e third to the eighth day was 259 mg. per cent, and the 5 cats sacrificed from the sixteenth to the sixtyurth day it was 245 mg. per cent.

Specimens of the pancreas, adrenal, pituitary, liver, d kidney were taken and fixed in modified Bouin's lution. Sections were stained by the method of omori (*1*) and with hematoxylin and eosin.

Histopathology. In the animals sacrificed early, the ncreas showed pyknotic nuclei and fragmentation the beta cells; later, some islets showed atrophy and yalinization.

The adrenal cortex showed most of the injury to e cells in the fascicular layer. In cases exhibiting vere damage there were areas of focal necrosis and yalinization. The medullary portion seemed to espe injury.

The anterior lobe of the pituitary showed damaged eas varying from hydropic degeneration with pykotic nuclei to necrosis with hyalinization and cystic egeneration. There was no evidence of injury to the osterior lobe.

The liver exhibited changes varying from congestion of the sinusoids, with granular degeneration of the cytoplasm and chromatolysis of the nuclei, to small and large areas of necrosis and fatty degeneration, involving in some cases more than half the liver cells.

In the kidneys there was mild congestion to marked swelling of the glomerular tufts which in some cases obliterated the space between Bowman's capsule and the tuft. The epithelium of the convoluted tubules showed hydropic degeneration, necrosis, and desquamation into the lumen. The straight tubules frequently contained hyaline casts. This acute injury to the kidneys tended to recovery. No distinct kidney damage was observed in some of the animals allowed to live a longer time.

Discussion. In these feeding experiments the severity of the diabetes seemed to be modified by the damaging effect of alloxan upon the adrenal cortex and the anterior lobe of the pituitary. This has been found true in surgically induced diabetes (*3*), when the adrenals or pituitary are removed before total ablation of the pancreas, and in alloxan diabetes (*2*). It is for that reason, we think, that these animals did not need glucose to tide them over the hypoglycemic stage, or insulin for the hyperglycemia.

From the work of Tipson and Ruben (*4*) it appears probable that alloxan (or its reduction products) occurs normally in animal bodies. They obtained indications that it occurs in highest concentration in the liver, which may be the organ that changes it to a less toxic substance, e.g. urea.

When alloxan is introduced into the animal body via the alimentary canal, it reaches the liver first and in highest concentration. The ensuing destruction of liver cells results in impaired liver function, which may be the reason our animals have shown more adrenal, pituitary, and kidney damage than in experiments reported by others in which the drug was introduced parenterally.

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Sex Hormonal Action and Chemical Constitution

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The following communication presents a new hypothesis regarding the essential chemical and structural features sufficient for male and female sex hormonal activity as evidenced by comb growth in the

capon and production of estrus in the ovariectomized rat.

In 1941 Giacomello and Bianchi (*8*), through crystallographic studies, revealed that estrone and diethylstilbestrol are molecules of identical length, 8.55 A. This fact has suggested a means of classifying all substances showing estrogenic activity if the hypothesis is made that an optimum distance (D) of 8.55 A. between the hydroxyl or keto groups in the estrogens is essential for maximum activity. Such an hypothesis gives a division of the estrogenic substances into four classes:

I. Substances in which the distance, D, is very nearly the optimum, 8.55 A. These substances show the highest estrogenic activity.

II. Substances in which the distance, D, is appreciably larger than 8.55 A. These substances show decreasing estrogenic activity in proportion to the deviation from the optimum distance, 8.55 A.

III. Substances in which the distance, D, is appreciably less than 8.55 A. These substances also show decreasing estrogenic activity in proportion to the deviation from the optimum distance, 8.55 A.

IV. Substances which have the proper distance, D, but possess no hydroxyl or keto groups.

TABLE 1

Group	Substance	Distance (A.)	Activity (R.U.)
I.	trans-4,4′-dihydroxy-α, β-diethylstilbene (*3*)	8.55	.3 γ
	trans-1,2-di-α-(4-hydroxy-naphthyl)-1,2-diethylethylene (*2*)	8.56	<10 γ
	1-methyl-2-(4-hydroxy-phenyl)-3,4-dihydro-6-hydroxynaphthylene (*10*)	8.56	.5 γ
	3,9-dihydroxy-5,6,11,12-tetrahydrochrysene* (*12*)	8.75	10 γ
II.	1,3-di-(4-hydroxyphenyl)-1,2-diethylpropane (*13*)	9.8	5 mg.
	1,4-di-(4-hydroxyphenyl)-2,3-diethylbutane (*1*)	12.0	inactive
	2,8-dihydroxy-5,6,11,12-tetrahydrochrysene (*4*)	9.45	150 γ
III.	trans-3,3′-dihydroxy-α, β-diethylstilbene (*9*)	7.7	less than 4,4′ analogue
	trans-2,2′-dihydroxy-α, β-diethylstilbene (*9*)	5.9	less than 3,3′ analogue
	p,p′-dihydroxydiphenyl-ether (*6*)	8.0	100% estrus with 80 mg.
	p,p′-dihydroxydiphenyl (*6*)	7.1	100% estrus with 100 mg.
IV.	triphenylchloroethylene (*7*)	8.56	65 γ

* Number the chrysene ring as in *Chemical Abstracts*.

Examples of each of these classes are listed in Table 1 together with the calculated distances, D[1], and the biological activities of the compounds.

The high activity of the substance, triphenylchloroethylene, indicates the critical distance (D = 8.55 A.) to be the distance between two hydrogen bond-forme which may be –OH groups (keto groups reducible enolizable to –OH) or simply hydrogen atoms th have been activated by the inductive effect. The i ductive effect is enhanced by the insertion of chlorine atom in this latter case. This hypothesis further borne out by the following facts:

1. Hydroxy derivatives are always much more acti estrogens than the corresponding keto analogues.

2. Ethers of the sex hormones decrease in activi in the order of difficulty of hydrolysis. Ethers a esters which are very stable to hydrolysis are inacti (*5*).

3. Triphenylchloroethylene is a more powerful est gen than triphenylethylene. This may be accounted f by the fact that the parahydrogens of this latter co pound become stronger hydrogen bond-formers wh chlorine is substituted for the ethylenic hydrogen by t inductive effect.

4. Tetraphenylethylene and diphenylethane show estrogenic response in 100-mg. doses in spayed ra thus indicating the importance of the chlorine in p ducing a highly active compound (*6*).

Considerations similar to the above have led an hypothesis basic to androgenic activity. All these ideas are summarized in the following, togeth with certain experimental data and predictions th have been made.

A given substance may be estrogenic if it consis of a rather large, rigid, and inert molecular structu with two active hydrogen bond-forming groups (e phenolic hydroxyl groups) located at an optimum di tance of 8.55 A. from one another. In particular, t substance trans-p,p′dihydroxyazobenzene meets t requirements for an estrogen (*11*) and, in spite its obvious chemical and physical differences from t natural and synthetic estrogens, shows definite est genic activity in dosages of from 10 to 15 mg. injec subcutaneously into spayed rats and in much smal dosages when applied directly to the vagina.

If the active groups are at a distance of appro mately 9–10 A. and are of somewhat weaker hydrog bond-forming character (e.g. secondary alcoho hydroxyl groups), then the substance may have a drogenic activity. The prediction is made, upon t basis of this hypothesis, that certain nonsteroid su stances will show male hormonal activity (e.g. the p hydro derivatives of trans-diethylstilbestrol and p hydro-2(p-hydroxyphenyl)-6-hydroxynaphthalene). is also noted that the dosage required to produce androgenic effect in rats by the most active androg is vastly greater than the quantity of estrogen need to produce estrus in the rat. This may be explain by the greater hydrogen bond-forming power "estrogenic hydrogen" (which is usually due to p

[1] The distances were calculated by means of bond angle and distance values taken from L. Pauling, *Nature of the chemical bond*. Ithaca: Cornell Univ. Press, 1942.

ic -OH groups) as compared to the weaker hydro- bond-forming power of the androgenic hydrogen , secondary alcoholic hydrogen).

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ffect of Altitude Anoxia in Provoking elapse in Malaria

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he opinion is widely held that anoxia tends to ecipitate relapse in individuals with latent malaria). This view, founded on clinical observation over period of many years, received additional support ring World War II when, with the increase in both incidence of malaria and air travel, relapses of laria were observed to occur following aerial flight. cently, Gajewski and Tatum (*2*), studying the phe- menon of relapse in avian malaria, succeeded in in- cing relapse in from 2 to 7 days in all of more n 100 canaries with latent *P. cathermerium* infec- n by exposing the birds continuously to an oxygen sion of approximately 75 mm. Hg.

n the present study an attempt was made to induce apse in human subjects using a short, yet moder- ly severe, anoxic assault such as might occur during h-altitude flight. Fifty overseas returnees from rious Army Air Force installations who gave his- ies of two or more recent attacks of malaria were subjects. They were exposed for 1 hour in a low- essure chamber to a simulated altitude of 18,000 t without supplementary oxygen (oxygen tension, proximately 80 mm. Hg.).

ince the subjects' statements were the sole source information in obtaining data as to the number, rcumstances, and dates of their previous attacks, it was not possible in all cases to separate reinfections from relapses; therefore, only the total number of previous attacks was recorded in each case. While the subjects were at the simulated altitude, continuous oximeter readings of oxyhemoglobin concentration in the blood were made. Thick blood smears were made immediately before and immediately after the chamber flight, and daily thick blood smears were made for 5 days thereafter. The subjects remained in the hospital under observation for a minimum of 6 days following the chamber flight, and at the time of hospital discharge were instructed to report subsequent relapses. All subjects, with the exception of one individual who had finished quinine treatment of his last relapse only 3 days before the chamber run, had discontinued atabrine or quinine administration 15 days or more prior to the anoxic episode.

The mean oximeter reading of the group was 76.4 per cent. None of the 50 subjects experienced relapses within 7 days of the chamber flight. Eight of the subjects, however, had relapses at periods varying from 8 to 35 days following the flight. None of the subjects included in the series had positive blood smears before entering the chamber or during the succeeding 5-day period when daily blood examinations were made. Data pertaining to the 8 subjects who relapsed subsequent to the 7-day period are shown in Table 1.

TABLE 1

DATA ON 8 CASES WHICH RELAPSED LATER THAN 7 DAYS AFTER THE ANOXIC EXPERIENCE

Case No.	No. of previous attacks	Days since last attack	Days since last atabrine	Relapses: Days after chamber flight	Relapses: Type	Relapses: Days after last attack
3	7	25	17	8	Vivax	33
6	2	36	31	8	..*	42
8	6	12	3 (quinine)	23	..*	33
13	4	33	17	18	Vivax	51
42	9	26	15	30	..*	56
43	2	26	18	35	Vivax	61
44	5	52	46	17	Vivax	69
49	7	42	35	18	Vivax	60

* Type not reported.

In summary, neither relapse nor parasitemia was observed in a group of 50 individuals giving histories of recent malaria within a period of 7 days following exposure to the anoxia produced by a 1-hour stay at 18,000 feet in a low-pressure chamber.

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The Transmission of *Litomosoides Carinii*, Filariid Parasite of the Cotton Rat, by the Tropical Rat Mite, *Liponyssus bacoti* [1]

Roger W. Williams[2] and Harold W. Brown[3]

The authors recently reported (*2*) the development of *Litomosoides carinii*, filariid parasite of the cotton rat, *Sigmodon hispidus*, from the microfilarial to the infective stage in the tropical rat mite, *Liponyssus bacoti*. We now have experimental evidence that the tropical rat mite serves as a vector of this filariid.

Four albino rats, 30 days old, were used in the experiment. Two of these rats were placed in individual wire-mesh cages, each cage being placed in a separate box beside a similar cage containing an infected cotton rat. A colony of mites were developed on each of the two cotton rats in their respective boxes prior to the introduction of the albino rats. The position of the two cages in each of the two boxes was periodically interchanged so that the mites could more readily have access to the albino rats after having fed on the infected cotton rats. The other two albino rats, which were used as control animals, were placed together in a wire-mesh cage. This cage was placed in a box, which harbored no mites, beside a similar cage containing a cotton rat heavily infected with *L. carinii*. The position of the cages containing the control rats and the infected cotton rat were also interchanged periodically. All three boxes, the two with the mites and the one without mites, were kept in the same room.

The two albino rats subjected to contact with the mites were autopsied 42 and 44 days after being placed in the mite colonies with the infected cotto rats. The rat autopsied after 42 days contained sev *L. carinii* worms in the pleural cavity ranging i length from 1.165 to 12 mm., while the second r contained two worms, one 9 mm. and the other 4 mm. in length. The control rats were negative wh autopsied after 44 days.

The length of the infective stage within the mit was found to be from 800 to 1,000 μ. It is interestin to note that the smallest worm found in the pleur cavity of the infected albino rat was only 165 longer than the largest infective form found withi the mites. This indicates that either the parasi reaches the pleural cavity soon after gaining entran to the rat or that growth is very slow until the pleur cavity is reached. It is also of interest that a leng of 42 mm. could be attained in 44 days or less.

In a similar experiment a cotton rat and an albin rat, which had been experimentally infected by th mite vector, exhibited microfilariae in their blood 8 days after exposure to infected mites. Epidemiolog ical evidence indicated by naturally infected ra points to the possibility that rats may be infected an exhibit microfilariae as early as 50 to 60 days afte exposure to infection.

Chandler (*1*) reported that at the Rice Institute a albino rat which had been housed with cotton ra infected with this filariid parasite was also found t be infected with this worm. The mode of infectio was unknown.

Now that it is possible to infect rats readily in th laboratory, new fields of filariasis investigation ar open. Immunological and prophylactic drug studie can be conducted, and age resistance of worms t various chemotherapeutic agents can be studied.

[1] This study was made possible through the financial support of the John and Mary R. Markle Foundation.

[2] Lt. H(S), USNR, assigned for research in Filariasis to the School of Public Health of the Faculty of Medicine, Columbia University.

[3] Professor of parasitology, School of Public Health of the Faculty of Medicine, Columbia University.

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Scanning Science—

The Eighth Annual Report of the Trustees of the Marine Biological Laboratory at Woods Hole has just been issued, and shows that the summer of 1895 was the most successful in the history of the Laboratory. At different times during the summer there were 63 investigators present, 42 of whom occupied special research rooms. At present 25 colleges subscribe for investigator's rooms, besides five societies, including the American Association for the Advancement of Science and the American Society of Naturalists.

—13 March 1896

Science Legislation

Text of the New Kilgore-Magnuson Bill

A bill to promote the progress of science and the useful arts, to secure the national defense, to advance the national health and welfare, and for other purposes.

Declaration of Policy

Sec. 2. The Congress hereby finds that a full development and application of the Nation's scientific and technical resources is essential for the national defense, national prosperity, and the national health and welfare. The Congress declares it to be the purpose of this Act among other things to provide support for scientific research and development, to enable young men and women of ability to receive scientific training, to promote the conservation and use of the natural resources of the Nation, to correlate the scientific research and development programs of the several Government agencies, to achieve a full dissemination of scientific and technical information to the public, and to foster the interchange of scientific and technical information in this country and abroad. The Congress finds it essential for these purposes to create a central scientific agency within the Federal Government.

National Science Foundation

Sec. 3. (a) There is hereby established an independent agency of the Federal Government to be known as the National Science Foundation (hereinafter referred to as the "Foundation"), and administered by an Administrator (hereinafter referred to as the "Administrator") who shall be appointed by the President, by and with the advice and consent of the Senate, and shall receive compensation at the rate of $15,000 per annum. The President, before appointing an Administrator, shall consult with and receive the recommendations of the National Science Board created in section 4 (and hereinafter referred to as the "Board"). The Administrator shall appoint a Deputy Administrator, who shall perform the functions of the Administrator during his absence or when there is a vacancy in the office of the Administrator, and shall perform such other duties as may be delegated to him by the Administrator. The Deputy Administrator shall receive compensation at the rate of $12,000 per annum.

(b) There shall be within the Foundation a Division of Mathematical and Physical Sciences, a Division of Biological Sciences, a Division of Social Sciences, a Division of Health and Medical Sciences, a Division of National Defense, a Division of Engineering and Technology, a Division of Scientific Personnel and Education, a Division of Publications and Information, and such additional divisions, not to exceed three in number, as the Administrator may from time to time establish after receiving the advice of the Board. The functions of each division shall be prescribed by the Administrator after receiving the advice of the Board, except that until the Administrator and the Board have received general recommendations from the Division of Social Sciences regarding the support of research through that Division, support of social science research shall be limited to studies of the impact of scientific discovery on the general welfare and studies required in connection with other projects supported by the foundation. Each division shall be headed by a Director, who shall be appointed by the Administrator and shall receive compensation at the rate of $12,000 per annum.

(c) Except as provided in section 4, the Administrator shall appoint and fix the compensation of such personnel as he may deem necessary to carry out the provisions of this Act. Such appointments shall be made and such compensation shall be fixed in accordance with the provisions of the civil-service laws and regulations and the Classification Act of 1923, as amended, except that, when deemed necessary by the Administrator for the effective administration of this Act, expert scientific, technical, and professional personnel, including part-time personnel, may be employed without regard to the civil-service laws, and their compensation fixed without regard to the Classification Act of 1923, as amended.

National Science Board and Divisional Scientific Committees

Sec. 4. (a) The Administrator, in exercising his authority under this Act, shall consult and advise with a National Science Board and, through the Directors of the several divisions, with divisional scientific committees, on all matters of major policy,

program, or budget. The Board shall consist of nine members appointed by the President, by and with the advice and consent of the Senate, from among persons who are especially qualified to promote the broad objectives of this Act, plus the chairman of the several divisional scientific committees. The scientific committee for each division, except the Division of National Defense, shall consist of not less than five and not more than fifteen members appointed by the Administrator, with the advice and approval of the Board, except that the initial members of each such divisional scientific committee shall be appointed by the Administrator with the advice and approval of the Board members appointed by the President.

The scientific committee for the Division of National Defense shall consist of not more than forty persons, of whom at least half shall be civilians appointed by the Administrator, with the advice and approval of the Board, and the remaining members shall be divided equally between such chiefs of such services and divisions of the War Department and such chiefs of such bureaus and offices of the Navy Department as the Secretary of War and the Secretary of the Navy, respectively, may from time to time designate. There shall be within the divisional scientific committee for the Division of National Defense a five-man executive committee consisting of the chairman of the divisional scientific committee, as chairman; two civilian members elected annually by the civilian members of the divisional scientific committee; together with one Army officer, and one naval officer, each of whom should be charged in their respective Departments with the coordination of research, designated by the Secretary of War and the Secretary of the Navy, respectively.

Each divisional scientific committee shall be reasonably representative of the major scientific interests and functions of its division. Members of the Board appointed by the President and members of the divisional scientific committees appointed by the Administrator shall serve for three-year terms, except that (1) at least one-third of such members originally appointed shall be appointed for one-year terms, and at least another third for two-year terms, and (2) any member appointed to fill a vacancy occurring prior to the expiration of the term of his predecessor shall be appointed for the remainder of such term. No person thus appointed to serve as a member of the Board or any divisional scientific committee shall be eligible again to serve as a member of the same group until the expiration of one year after his term has expired, except that a member appointed for a term of less than three years may be appointed for a succeeding three-year term.

(b) The Board and each divisional scientific committee shall annually elect its own chairman from among its own members, and shall devise its own rules of procedure. The Board and each such committee shall meet at the call of its own chairman or at such times as may be fixed by itself, but not less than [illegible] times each year, including at least once each calendar quarter. Vacancies in the membership of the Board or of any divisional scientific committee shall not impair the authority of the remaining members to execute its functions, and a majority of the members of the Board or any divisional scientific committee as constituted at any given time shall constitute a quorum.

The Board shall appoint and prescribe the duties of an executive secretary of its own selection who shall receive compensation at a rate, not exceeding $12,000 per annum, to be fixed by the Board. The Administrator shall pay the compensation of such executive secretary and may furnish the Board and the divisional scientific committees such additional personnel, and such facilities, services, and supplies as may be necessary for the proper performance of the functions of the Board and the divisional scientific committees.

(c) The Board shall continuously survey the activities and management of the Foundation, and shall periodically evaluate the achievements of the Foundation in accomplishing the objectives of this Act. Each divisional scientific committee shall survey continuously the scientific field which it encompasses, shall undertake to determine the specific scientific needs of such field, and shall evaluate proposed programs and projects. The Board and each divisional scientific committee shall, upon its own initiative or upon request by the Administrator, make appropriate recommendations and reports relating to its duties and findings. The Board and each such committee shall have full access to all information in the possession of the Foundation.

(d) The Administrator shall render an annual report to the President and the Congress, summarizing the activities of the Foundation, together with such recommendations as he may deem appropriate. The Board shall annually and at such other times as it deems necessary, make such recommendations to the President and the Congress as in its opinion will further the objectives of this Act. The annual report shall include such independent recommendations concerning the budget, organization, and management of the Foundation, and such other recommendations as the Board and the divisional scientific committees may deem necessary to better effectuate the purposes of

this Act. The annual report shall include whatever dissenting opinions may be submitted for that purpose by individual members of the Board or of the divisional scientific committees. The Administrator shall, whenever requested by the Board or any divisional scientific committee, publish and disseminate widely any recommendations or reports prepared by the Board or such committee.

(e) Members of the Board and of the divisional scientific committees shall receive compensation at the rate of $50 for each day engaged in the business of the Foundation, and shall be reimbursed for their necessary travel and other expenses incurred in the work of the Board or of any such committee. Persons holding other offices in the executive branch of the Federal Government may serve as members of the Board or any divisional scientific committee, but they shall not receive remuneration for their services as such members during any period for which they receive compensation for their services in such other offices, nor, except for representatives of the War and Navy Departments on the scientific committee for the Division of National Defense, shall they in their services as such members serve as representatives of the Government agency by which they are employed.

(f) Members of the Board and of any divisional scientific committee established under the provisions of this Act, and any other officers or employees of the Foundation, shall be chosen without regard to their political affiliations and solely on the basis of their demonstrated capacity to carry out the purposes of the Foundation and their fitness to perform the duties of their office.

(g) The Administrator may create such specialized additional advisory committees or employ the services of such advisory personnel as he may deem necessary to better effectuate the objectives of this Act. Persons so employed shall be reimbursed for their necessary travel and other expenses incurred in the work of the Foundation. Such persons may be noncompensated or may receive compensation at a rate not to exceed $50 for each day of service. Members of the Board and of the divisional scientific committees, and any other person serving in an advisory capacity, pursuant to this section, may serve as such without regard to the provision of sections 109 and 113 of the Criminal Code (18 U. S. C., secs. 198 and 203) or section 19 (e) of the Contract Settlement Act of 1944, except insofar as such sections may prohibit any such person from receiving compensation in respect of any particular matter which directly involves the Foundation or in which the Foundation is directly interested.

Support of Research and Development

Sec. 5. (a) The Administrator is authorized to enter into contracts or other arrangements pursuant to which he will finance, in whole or in part, or otherwise support, research and development activities to be carried on by other Government agencies or by other organizations.

(b) Of the funds appropriated to the Foundation for research and development activities, not less than 15 per centum shall be available only for expenditure for research and development, pursuant to contracts or other financial arrangements made by the Administrator under this section, including contracts or arrangements to which subsection (c) is applicable, in each of the following fields: (1) National defense and (2) health and the medical sciences.

(c) Of the funds appropriated to the Foundation for research and development activities (excluding funds expressly appropriated for national defense), not less than 25 per centum shall be apportioned among the States as follows: Two-fifths shall be apportioned among the States in equal shares, and the remainder shall be apportioned among the States in the proportion that their respective populations bear to the population of all the States, determined according to the last preceding decennial census; and the amounts so apportioned to each State shall be expended only for carrying on research and development activities in the facilities of tax-supported colleges and universities, including the land-grant colleges, within such State pursuant to contracts or other financial arrangements made by the Administrator under this section. In making such contracts or other financial arrangements, the Administrator shall give each individual institution the widest latitude in its selection of individual research and development projects, but the Administrator shall not be required to expend funds in any institution unless it submits proposals for the expenditure of such funds which the Administrator finds to be consistent with such general program and standards as he may, after receiving the advice of the Board, establish in order to carry out the objectives and provisions of this Act. For purposes of this section the term "State" includes Alaska, Hawaii, and Puerto Rico. Of the funds appropriated to the Foundation for research and development activities (excluding funds expressly appropriated for national defense), an additional amount of not less than 25 per centum shall be expended in the facilities of nonprofit organizations without regard to the above limitations relating to State quotas or the tax-supported character of the organization. In meeting the requirements of this subsection, the Administrator may take into account whatever funds may be ex-

pended by the Foundation for facilities to be operated by the land-grant, tax-supported, or other nonprofit organizations, even though the title or ownership rights of such facilities remain with the United States.

(d) The activities of the Foundation shall be construed as supplementing and not superseding, curtailing, or limiting any of the functions or activities of other Government agencies authorized to engage in scientific research and development. Funds allocated by the Administrator to other Government agencies shall be utilized for projects approved by the Administrator and undertaken on behalf of the Foundation, and shall be in addition to, and not in lieu of, funds regularly appropriated to such other Government agencies.

(e) In all research and development activities financed or otherwise supported by the Foundation, the Administrator shall make every effort to eliminate restraints upon the free expression of scientific views and to insure full freedom in the exercise of creative talents, in the development of new ideas, and in the methods of research. Any person engaged in such research and development activities shall not be precluded from independently discussing, writing, or publishing his own views and conclusions relating to such research and development.

Scholarships and Fellowships

SEC. 6. The Administrator is authorized to award scholarships and fellowships to persons for scientific study or scientific work in any field of science, including but not limited to the mathematical, physical, biological, medical, and social sciences at nonprofit institutions of higher education, or other institutions, selected by the recipient of such aid, for such periods as the Administrator may determine, in the United States or in foreign countries. Persons shall be selected for such scholarships and fellowships solely on the basis of aptitude, within the limits of such quotas as may be established to insure an equitable selection of such persons from among the States and territories. Persons selected for such scholarships and fellowships may include employees of the Federal Government and such employees selected and detailed for scientific study or training shall not lose their status or seniority ratings for reason of absence from regularly assigned duties during the course of such study or training.

Register of Scientific Personnel

SEC. 7. The Administrator shall maintain a register of scientific and technical personnel and in other ways provide a central clearinghouse for information concerning all scientific and technical personnel in the United States and its possessions. No individual shall be listed in such register without his consent.

Use and Dissemination of Research Findi

SEC. 8. (a) The Administrator shall make
maintain an inventory of all current federally fina
research and development projects. In cooper
with the Commissioner of Patents, the Administ
shall establish a central register of all inventions,
coveries, patents, patent rights, and findings,
ing references to related data, in which the
States or any agency thereof has any right, titl
interest, or which pursuant to this section have
freely dedicated to the public. The Adminis
shall record, collect, index, and promptly publis
cause to be published significant data on all invent
and discoveries and other findings produced in
course of federally financed research and developm
activities, or arrange with other Government agen
for such publishing, recording, collecting, and in
ing. In consultation and collaboration with the
brary of Congress and other Government agen
the Administrator shall take such steps as he
deem necessary to make such information and o
available significant scientific and technical infor
tion accessible to the public, including the preparat
and distribution of reports, periodic catalogs, inv
tories, abstracts, translations, bibliographies, and
crofilm and other reproductions thereof; and for s
purposes the Administrator may utilize the facili
of Government agencies and other organizations
the extent that he deems necessary or desirable,
may contract for the expenditure of funds for s
purposes without regard to the provisions of secti
87 of the Act of January 12, 1895 (28 Stat. 622),
section 11 of the Act of March 1, 1919 (40 Stat. 12
(U. S. C., title 44, sec. 111).

(b) Each contract or other arrangement for fed
ally financed research or development entered i
between any Government agency and any organizati
shall provide that such organization will make av
able to such agency full data on all inventions, d
coveries, patents, patent rights, and findings produc
in the course of such research or development, incl
ing such reports with respect thereto as may be
quired by such agency. Each Government agen
upon the request of the Administrator, shall ma
available to him such data and such reports with
spect to research and development activities financ
by such agency, as may be necessary for the purpos
of this section.

(c) All inventions, discoveries, or findings in whi
the United States (or any Government agency), no
or hereafter, hold any rights, including patent right
shall be made available to the public on a nonexclusi
and on a royalty-free basis to the extent the Unit
States or such agency is entitled to do so under th

held by it. Except as provided hereafter in ubsection and in subsection (d), any invention, very, or finding hereafter produced in the course derally financed research and development shall, er or not patented, be made freely available to ublic and shall, if patented, be freely dedicated e public. The requirements of this subsection, extent that they require modification of con- or other financial arrangements already entered by the United States (or any Government agency) not go into effect until one hundred and twenty fter the date of enactment of this Act.

) The head of any Government agency financing contract, or otherwise administering, federally ced research and development activities, may, by lation in the contract or by other advance agree- ts with any organization, provide for the retention he organization, or by the inventor, or by their nees of such patent rights based on discoveries, ntions, or findings produced in the course of such rch and development as the head of such Gov- nent agency deems fair and equitable, and con- nt with the national interest: *Provided*, That (1) head of such Government agency shall, before ring into any such contract or agreement, make a ing that the agency has made every reasonable rt to arrange for the conduct of the necessary re- ch and development without entering into a con- t containing such provision; (2) the organization l contribute or shall have contributed substantially he development of the particular inventions, dis- eries, or findings for which patent rights are re- ed through earlier or current research and de- pment activities financed by the organization; in every case, the contract or agreement shall vide for at least an irrevocable, nonexclusive, alty-free license for governmental purposes to the ted States; and (4), in the case of any nonprofit anization, the head of such Government agency ther determines (A) that the research and develop- t is essential in the field of national defense or in h other fields as the President may specify for such pose and (B) that the patent rights retained will be used to serve the special benefit of any organi- ion conducted for profit or of any individual, and l be made available or licensed to applicants on a exclusive, uniform, and reasonable royalty basis. n the administration of the provisions of this sub- tion, the head of any Government agency shall be ided by such rules and regulations as the President y deem necessary and prescribe by Executive order.

(e) The Administrator shall make a quarterly re- rt to the President and to the Congress concerning tracts and agreements containing the provisions thorized by subsection (d). This report shall include a list of all contracts and agreements containing such a provision entered into by any Government agency during the preceding quarter, the reasons supporting the approval of such provision in each case, the amount of Federal funds expended or to be expended under each contract or agreement containing such a provision, the name of the organization with which the contract or agreement was made, and the general nature of the patent rights reserved for private use in each case. The report shall also include a list of all inventions, discoveries, or findings in which patent rights were permitted to be retained pursuant to the provisions of subsection (d) and which were first recorded or finally authorized during the preceding quarter, identification of the contract or agreement under which such inventions, discoveries, or findings were produced, and the nature of the rights retained. The report shall also include the Administrator's recommendations, if any, for such further Executive or legislative action as he may deem necessary.

(f) Notwithstanding any other provision of this Act, the President, or any person designated for that purpose by him, may exempt from the provisions of this Act relating to dedication to the public, publication, dissemination, or making available, any scientific or technical information, data, patents, inventions, or discoveries produced in the course of federally financed research or development or in which the United States holds any rights, if and so long as the President or such designated person determines that such exemption is essential in the interest of national security.

International Cooperation

Sec. 9. (a) The head of any Government agency is hereby authorized, with the approval of the President and through the Department of State, to conclude reciprocal agreements with foreign governments or agencies thereof, relating to the interchange of scientific and technological information (including models and samples for information purposes), and the use and availability of patents and patent rights owned or controlled by the respective governments.

(b) The Administrator is hereby authorized, with the approval of the President and through the Department of State, to cooperate in any international research or development activities consistent with the purposes or provisions of this Act and to expend for such international research activities such sums within the limit of appropriated funds as the Administrator may deem desirable.

(c) The Administrator may defray the expenses of representatives of Government agencies and other organizations and of individual scientists to accredited international scientific congresses and meetings when-

ever he deems it necessary in the promotion of the objectives of this Act.

Interdepartmental Coordination

Sec. 10. (a) There is hereby established an Interdepartmental Committee on Science, to consist of the Administrator, as Chairman, and the heads (or their designees) of such Government agencies engaged in or concerned with the support of scientific activity to a substantial degree as the President may from time to time determine. The Interdepartmental Committee shall meet whenever the Chairman so determines, but not less than once a month.

(b) The Interdepartmental Committee shall advise and assist the Administrator in gathering and correlating data relating to the scientific research and development activities of the Federal Government; shall study and evaluate such data in relation to the program of the Foundation and the scientific research and development programs of the other Government agencies; and shall make such recommendations to the Foundation and other Government agencies as in the opinion of the Committee will serve to aid in effectuating the objectives of this Act and other legislation providing for Federal support of scientific research and development. The Administrator, in consultation with the Interdepartmental Committee, shall, from time to time, make recommendations to the President for the achievement of maximum effectiveness in the conduct of all federally financed research and development.

Miscellaneous

Sec. 11. (a) To enable the Administrator to carry out his powers and duties, there is hereby authorized to be appropriated annually to the Foundation, out of any money in the Treasury not otherwise appropriated, such sums as may be necessary to carry out the provisions of this Act. The funds appropriated to the Foundation, as herein authorized, and funds hereafter appropriated to any Government agency for scientific research or development, as herein defined, shall, if obligated during the fiscal year for which appropriated, remain available for expenditure for four years following the expiration of the fiscal year for which appropriated. After such a four-year period, the unexpended balances of appropriations shall be carried to the surplus fund and covered into the Treasury.

(b) The materials or equipment purchased by Federal funds or furnished by the Federal Government in connection with research and development activities shall be the property of the United States. The Administrator shall not, however, through the Foundation or its own employees, operate any laboratories, pilot plants, or other such scientific or technical facilities which he may acquire.

(c) In carrying out his functions under this the Administrator is authorized—

(1) to prescribe such rules and regulations as he deem necessary to govern the manner of the opera of the Foundation and its organization and person

(2) to make such expenditures as may be neces for carrying out the provisions of the Act;

(3) to enter into contracts, or amendments or mo fications of contracts, without performance or o bonds, and without regard to section 3709 of the vised Statutes (U. S. C., title 41, sec. 5) in the of all contracts which relate to scientific research development;

(4) to make advance, progress, and other paym which relate to scientific research or development w out regard to the provisions of section 3648 of the vised Statutes (U. S. C., title 31, sec. 529);

(5) to acquire by purchase, or otherwise, hold a dispose of by sale, lease, loan, or otherwise, real a personal property of all kinds necessary for, or res ing from, scientific research or development; and

(6) to prescribe, with the approval of the Co troller General of the United States, the extent to wh vouchers for funds expended under contracts for sci tific research and development shall be subject to ite zation or substantiation prior to payment, without rega to the limitations of other laws relating to the expen ture of public funds and accounting therefor.

(d) The provision of the Reorganization Act 1945 shall be applicable with respect to the Foun tion, and with respect to the transfer of agencies a functions to and from the Foundation, without rega to the provisions of section 5 (e) of such Act.

(e) The Office of Scientific Research and Devel ment, and its constituent committees shall be tra ferred to the Foundation; together with such of t powers, functions, duties, personnel, property, record funds (including all unexpended balances of appr priations, allocations, or other funds now availabl contracts, assets, and liabilities as may be determin by the President. The National Roster of Scient and Specialized Personnel shall be transferred fr the Department of Labor to the Foundation, togeth with such of the personnel, records, property, a balances of appropriations as have been utilized are available for use in the administration of su roster as may be determined by the President. T transfers provided for in this subsection shall take e fect at such time or times as the President shall dire

(f) If any provision of this Act, or the applicati of such provision to any person or circumstance, held invalid, the remainder of this Act, or the appl cation of such provision to persons or circumstan other than those as to which it is held invalid, sha not be affected thereby.

(*Continued on p. 240*)

Association Affairs

Housing Arrangements in St. Louis

St. Louis promises to be an ideal place for the first large-scale convention held by the AAAS for the past four years. Its hotels will provide 54 meeting rooms, while the St. Louis Municipal Auditorium or Kiel Memorial, engaged for the Association's exhibitions, will furnish an additional 16 meeting halls, 12 of which have a seating capacity of 250 or more.

Even so, our tentative program shows that as many as 40 to 60 meetings may be in progress at one time, and since most of these consist of groups of 100 or more, the necessity of housing the sessions of some societies apart from their headquarters hotel is apparent. This is even more true this year than in prewar years.

Reservations for sleeping quarters in St. Louis should be arranged through the Housing Bureau, 910 Syndicate Trust Building, St. Louis 1, Missouri, and must be made not later than 17 March. Requests for rooms to be occupied by two or more are more likely to be honored than those for single rooms.

Even with the best cooperation between the membership and the Housing Bureau, it is clear at this time that sleeping quarters in hotels are going to be completely inadequate. Every agency is now being used to track down every available room in private residences. These rooms will be comfortable, but not distinguished—they will be in homes whose families have on other occasions "rented a room for a night" to tourists or to conventioneers. When these resources are exhausted there will still be an acute room shortage. The officers and the committee on local arrangements need to have access to the homes of professional people where under ordinary circumstances to rent an extra room would be an unheard of practice. This note is a direct appeal to the membership and their friends in and around St. Louis to open their homes to their colleagues from out of town. In cases where it is possible at all, a person going to St. Louis for the meetings should make his own arrangements.

News and Notes

Dr. Morris B. Jacobs, senior chemist, Department of Health of the City of New York, has been designated chief of the Chemical Laboratory of the Department of Health.

Dr. Elmer L. Sevringhaus, professor of medicine at the University of Wisconsin, has accepted an appointment as director of clinical research for Hoffman-La Roche, Inc., and will assume his new post on 15 March at the laboratories in Nutley, New Jersey. The research and clinical program in endocrine, metabolic, and nutritional problems at the Wisconsin General Hospital will be carried on by Dr. Edgar S. Gordon, who has been associated with Dr. Sevringhaus for several years and who returned from military duty in January 1946.

Dr. Victor T. Allen has been appointed director of the Department of Geology at Saint Louis University. He has been on wartime leave of absence from his position as professor of geology at Saint Louis University since 1942, serving as commodity geologist for clay minerals in the U. S. Geological Survey. He will take over his new duties at the beginning of the first summer session on 13 May 1946.

Joseph A. Volk, radio engineer and graduate of the Technical University of Stuttgart, Germany, has been appointed instructor in engineering in the Institute of Geophysical Technology of Saint Louis University.

Dr. Howard de Forest, professor of botany at the University of Southern California for the past 23 years, retired in November 1945. Dr. de Forest is president of the chapter of Sigma Xi at the University for 1945–1946.

Dr. Harrison Davies, appearing before the Senate Committee on the control of atomic energy on 28 January, representing the Federation of Atomic Scientists, took the position that military men should not hold policy-making positions on any board or control commission. He said that it was "in the best tradition" of American Government that policy be set by civilians. "A subject fraught with such tremendous

significance to our foreign policy as the development of atomic energy in this country must certainly be freed from every vestige of military control."

Dr. Woodrow W. Middlekauff, Cornell University, has recently been appointed assistant professor of entomology and assistant entomologist in the Agricultural Experiment Station, Division of Entomology and Parasitology, University of California, Berkeley. Dr. Middlekauff has recently left the army.

Professor Charles C. Grove, of the CCNY Mathematics Department, retired on 1 February after 25 years of service.

Capt. Alexander B. Klots, Sn.C., assistant professor of biology, College of the City of New York, delivered an address on 14 January on "Aeroplane Spraying and the New Uses of DDT" to the staff of the Servicio Especial de Saude Publico in Belem, Para, Brazil.

Dr. Hallowell Davis, associate professor of physiology at Harvard Medical School, will join the staff of Central Institute for the Deaf, St. Louis, as director of research. In collaboration with other members of the staff he will direct the expansion of the research and clinical program dealing with all phases of deafness, hearing, and speech defects.

Lt. Col. Francis E. Colien, Sn.C., who has served as executive officer, chief of Laboratory Service, and medical inspector, will resume his duties as associate professor of bacteriology and public health and preventive medicine at Creighton University School of Medicine and as director of laboratories, City Health Department, Omaha, Nebraska.

Dr. James N. DeLamater has recently been appointed assistant professor of tropical medicine and parasitology in the School of Medicine of the University of Southern California. Before joining the staff of the University Dr. DeLamater was executive officer of the Department of Epidemiology at the Naval Medical School, Bethesda, Maryland.

Dr. Eric T. B. Gross has been appointed professor of electric power system engineering at Illinois Institute of Technology.

Announcements

Mr. C. N. Davies, of the Industrial Health Research Board, London School of Hygiene, has reported an observation to *Nature* (1945, **156**, 666) which will be of interest to readers in the United States:

In his book "Essays on the Floating-Matter of the Air" (1881), the physicist John Tyndall describes experiments which he carried out in 1876 refuting the doctrine of spontaneous generation of life. In the course of these experiments tubes of organic infusions were infected with organisms after exposure to the atmosphere. A number of cases occurred when such tubes, which were turbid and swarming with bacteria, became covered with *Penicillium glaucum,* three unspecified kinds being noticed. The bacteria in these tubes lost their translatory power and fell to the bottom, leaving the liquid between them and the superficial layer clear. Tyndall ascribes this to the success of the moulds in the struggle for existence and notes that access of oxygen to the body of fluid must have been hindered. He did not, however, test the clear liquid for its capacity to support newly implanted bacterial life. It is interesting to speculate upon what the consequences might have been had Tyndall allowed himself to be drawn from his main investigation.

Radio amateurs have made contacts over a range of 31 miles in the first use of super-high-frequency microwave bands outside the military and commercial tests.

A. E. Harrison, W6BMS, and Reuben Merchant, W2LGF, both of the Sperry Corporation, New York, using the 5,250- to 5,650-megacycle band, made contact at 5 miles and later reached 31 miles.

Microwaves, used in wartime radar, are found in super-high frequencies that have not been open to amateur radio operators before. Limited in distance, microwave beams are narrower than ordinary waves and permit use of smaller antennae and directional equipment not practical at lower frequencies—*Science Service.*

The Givaudan-Delawanna Corporation has granted to Dr. P. B. Price, professor of surgery, University of Utah, $5,250 for the investigation of skin disinfection.

The Armored Medical Research Laboratory, Fort Knox, Kentucky, is being reorganized by Col. Conn L. Milburn, Jr., MC, utilizing primarily civilian instead of military personnel. Tentatively the Laboratory is planning to continue its basic investigations into the physiological relationships of man to his environment and to the equipment that he uses in warfare. Somewhat greater emphasis will be placed on certain psychological aspects of these problems than was previously possible. Individuals interested in research work pertaining to the fields of biochemistry, physics, physiology, and psychology should write to Col. Milburn, Armored Medical Research Laboratory, Fort Knox, Kentucky.

Sixty-five members of the scientific faculty of Rutgers University have addressed a petition to President Truman and their Congressional representatives urging international control of atomic energy and free

interchange of scientific ideas. The Rutgers faculty members stated their belief that the security of the United States can be achieved only through international cooperation for the joint control of atomic energy and atomic weapons. "We believe," their petition said, "that a policy of secret research and exclusive national control can only result in a ruinous competitive armaments race in which all the nations of the world will join, leading to the danger of a new and catastrophic world war. From such a war no people will emerge free, if indeed, they survive at all." They urged that the United States immediately invite Great Britain and the Soviet Union to a conference to prevent competitive armaments and to take up the problems arising from the development of atomic energy.

Stating further their belief that any legislation which stifles free and open scientific investigation and public surveillance and criticism of the application of atomic energy will hamper scientific progress, undermine peace, and thereby harm the national interest, the petitioners urged Congressional action to prevent it. They further urged that "security regulations be limited to direct military application of atomic power and that free research and right of publication be immediately resumed in the field of atomic physics."

Elections

The Rochester Academy of Science announces the following officers for 1946: Dr. Sherman C. Bishop, Department of Biology, University of Rochester, president; Dr. Gordon M. Meade, Medical School, University of Rochester, vice-president; Milroy N. Stewart, 172 Roosevelt Road, Rochester 10, secretary; William S. Cornwell, 109 Titus Avenue, Rochester 5, treasurer; and Mrs. David E. Jensen, Pittsford, New York, corresponding secretary. The Section chairmen are: Botany, Dr. Grace A. B. Carter, 30 Vassar Street, Rochester 7; Mineralogy, Robert C. Vance, Pittsford; Photography, H. Lou Gibson, 5274 St. Paul Street, Rochester 12; Astronomy, Paul W. Stevens, 2322 Westfall Road, Rochester, 10; Meteorology, Emil Raab, U. S. Weather Bureau, Municipal Airport, Rochester 11.

W. W. Horner, St. Louis consulting engineer was elected president of the American Society of Civil Engineers for 1946. The new vice-presidents are Arthur W. Harrington, district engineer, U. S. Geological Survey, Albany, and J. T. L. McNew, vice-president of Agricultural and Mechanical College, Texas.

Dr. Louis B. Howard, assistant chief of the U. S. Bureau of Agricultural and Industrial Chemistry, has been elected chairman of the California Section of the American Chemical Society.

Dr. M. Rocha e Silva has been elected president of the São Paulo branch of the Brazilian Biological Society, for the period January–December 1946. Dr. Rocha e Silva is head of the Department of Biochemistry and Pharmacodynamics at the Biological Institute of São Paulo.

The Genetics Society of America has elected the following officers for 1946: Dr. G. W. Beadle, president; Dr. Karl Sax, vice-president. Dr. L. H. Snyder is serving the third year of a three-year term as secretary-treasurer.

The Society of American Bacteriologists announces the election of the following officers to serve in 1946: Dr. James Craigie, Toronto, president; Dr. Thomas Francis, Jr., Ann Arbor, vice-president; Dr. Leland W. Parr, Washington, D. C., secretary-treasurer; Dr. M. J. Rosenau, Chapel Hill, and Dr. Frederick Smith, Montreal, councilors.

The Emory University Chapter of the Society of Sigma Xi has elected the following as officers for 1946: Dr. Evangeline Papageorge, president; Dr. W. B. Redmond, vice-president; Dr. L. W. Blitch, treasurer; Dr. A. C. Munyan, custodian; and Dr. R. T. Lagemann, secretary.

The Philosophical Society of Washington has announced the following officers for 1946: Francis M. Defandorf, president; Fred L. Mohler and Walter Ramberg, vice-presidents; Francis E. Johnston, corresponding secretary; Kenneth L. Sherman, recording secretary; and Frank C. Kracek, treasurer. On 5 January, George Ray Wait, retiring president, addressed the 1258th meeting of the Society on "Some Experiments Relating to the Electrical Conductivity of the Lower Atmosphere."

The Western Society of Naturalists held its Fifteenth Annual Winter Meeting at Mills College, Oakland, California, on 27–29 December. The following officers were elected for 1946: Laurence M. Klauber, Natural History Museum, San Diego, president; Gordon F. Ferris, Stanford University, vice-president; Herbert W. Graham, Mills College, secretary-treasurer; Boris Krichesky, University of California at Los Angeles, and Herbert L. Mason, University of California, Berkeley, members at large on the Executive Committee.

Meetings

The Southwestern Allergy Forum will meet in Houston, Texas, on 8–9 April under the chairmanship of Dr. Owen, Jackson, Mississippi. Dean C. D. Leake,

University of Texas Medical Branch, Galveston, will address the evening meeting on 8 April on the subject: "Drugs in Allergy."

The 1946 annual meeting of the American Leather Chemists Association is scheduled to be held at the Hotel Sagamore, Lake George, on 19–21 June.

Conditions Abroad

Dr. N. Voronikhin (Woronichin), of the Komarov Botanical Institute, Academy of Sciences, writes to Dr. William Randolph Taylor: "I and my comrades in the same specialty, except Dr. A. Elenkin, who died, are in good health and are working successfully. The Department of Sporogenous Plants of our Institute, including the phycological collections, are in splendid shape." Dr. Voronikhin has published extensively on freshwater algae. The late Dr. Elenkin was a foremost authority on the myxophycean algae.

Dr. Gregorio Velasquez, of the University of the Philippines, writes to Dr. William Randolph Taylor that the Department of Botany is resuming its work under the greatest difficulties but is making progress and is anxious to resume the marine algal survey of the islands begun before the war in conjunction with the University of Michigan. Dr. Eduardo Quisumbing, chief of the Natural History Museum, offers cooperation also. He reports the loss of Dr. José B. Juliano, a plant cytologist, during the war.

Dr. Julius Zweibaum, professor of histology at the University of Warsaw, Poland, has communicated recently with Dr. Ludwik Anigstein, of the University of Texas School of Medicine. After being arrested by the Gestapo and having escaped from jail, he was confined to the Warsaw ghetto, where he was wounded during the uprising and rescued from the ruins. With astonishing energy and determination Prof. Zweibaum is now rebuilding the Department of Histology, which has been completely destroyed by the Germans. All the laboratory equipment as well as the library have perished. There is an urgent need for microscopes, microtomes, incubators, glassware, and reagents. In view of complete lack of textbooks, J. Zweibaum is writing a new manual of histology. He is seriously handicapped by the lack of literature, a fountain pen, and typewriter.

L. B. Uichanco, dean, University of the Philippines College of Agriculture, Los Banos, Laguna, Philippines, has written to Dean William D. Funkhouser, University of Kentucky, Lexington, as follows:

I am certainly happy to be able to get in touch with you again after the Japanese had isolated us for three years from the rest of the world. The campus of my college is very different now from what it was when you and the late Richard C. McGregor paid me a visit several years ago. The retreating Japanese systematically set fire to most of the buildings. At present, we are almost starting again from the very beginning, with all of our collections, library, laboratory equipment, and records destroyed. Even our pedigreed farm animals and selected seeds are gone. I myself was under sentence of death in 1943, but I fortunately escaped with a dislocated left arm resulting from a severe and prolonged torture by the Japanese, and I cheated death for the second time last February when the Japanese massacred the Filipinos wholesale. I have recovered completely, however, and I am again at work with my colleagues on the faculty who nearly all fortunately escaped being murdered.

Recent Deaths

Dr. Waller Smith Leathers, 71, emeritus dean of Vanderbilt University's School of Medicine died at Nashville on 26 January.

Dr. Adriaan Van Maanen, 61, Mount Wilson Observatory astronomer, died on 26 January in Pasadena.

Prof. Leon Marchlewski, 80, Polish chemist and former rector of Jagellonian University, Cracow, has died in Cracow according to the Polish Press Agency.

Dr. Mazyck Porcher Ravenel, 84, first bacteriologist of the Pennsylvania State Livestock Sanitary Board, died of pneumonia on 14 January at Columbia, Missouri.

Dr. Ernest Noble Pattee, 81, founder and until his retirement head of the Syracuse University Chemistry Department for 51 years, died on 17 January.

Dr. George D. McLaughlin, 58, Director of B. D. Eisendrath Memorial Laboratory, Racine, Wisconsin, former professor of leather research and director of Tanners' Council Laboratory, University of Cincinnati, Ohio, died 15 October 1945.

Dr. T. A. Tengwall, Swedish botanist and agronomist, formerly vice-director of the Experiment Station, West Java, Buitenzorg; sometime director of the Institute for Tropical Agriculture, Antalya, Turkey, and director of the Research Department, Firestone Plantation Company, Liberia; and lately, rubber adviser to the Board for the Netherlands Indies, Surinam and Curaçao, New York City, died suddenly in New York City on 19 January.

Prof. Harry Bateman, 63, of the California Institute of Technology, died in Utah on 21 January while on his way to New York.

Dr. E. B. Holt, 72, an early behaviorist, died on 25 January in Rockland, Maine. He was a visiting professor of psychology at Princeton University from 1926 to 1936.

Letters to the Editor

CO_2 Baths

R. R. McGregor (*Science*, 1945, 102, 648) spoke of the use of silicone stopcock grease as a means of preventing the foaming in acetone-carbon dioxide "Dry Ice" baths.

His article brought up several points of interest to me, and possibly to other readers. He says that, because of the tendency to foam, "open flames in the vicinity may cause bad fires." The obvious answer to this is to use, as this laboratory does, other noninflammable liquids. We use a commercial brand of trichloroethylene, called "Triad" (DuPont Co.), as degreaser solvent. This solvent will not support combustion, gives all the effects that acetone does with "Dry Ice," and therefore has none of the fire hazards of acetone.

In several simple experiments after reading Mr. McGregor's article, it was found out that if the acetone is reasonably clean it will not foam anyway. In another experiment, the effect of silicone grease on trichloroethylene was determined. In this solvent, instead of cutting down the foaming—trichloroethylene will foam badly, too, at first, if it has been used repeatedly—the silicone increased it manyfold.

Croom Beatty, III, *Director*
Organic Research Laboratory
Sprague Electric Company
North Adams, Massachusetts

The Age of Lake Cahuilla

Lake Cahuilla is the name given by W. P. Blake to a very large shallow lake, covering an area of about 2,200 square miles, which formerly existed in the region of the present Colorado Desert. Long ago it dried up, leaving on the surface of the soil millions of fresh-water shells, both univalves and clams, of several different species. These species are living today, in much smaller numbers, in various parts of the west.

Much discussion has recently arisen concerning the age of this lake, some geologists thinking it might have existed as recently as 500 to 1,000 years ago. The end of the Pliocene period in California is not strongly marked in the marine formations, but on land or in the fresh waters it is abrupt, suggesting a considerable time interval. All the Pliocene birds are extinct; the Pliocene fresh-water shells described by Pilsbry are nearly all extinct, the exceptions being a few uncharacteristic forms; the Pliocene plants are regarded as extinct, though to some extent this is a matter of convention, the scanty remains showing no appreciable difference in several cases from living species. When we come to compare the next period, the Pleistocene, with the Recent, there is no such break. It is not unreasonable to say that we are still living in the Pleistocene. Hence, when we dispute whether Lake Cahuilla is Pleistocene or Recent (Holocene), the decision may not be evident. But during the Pleistocene, as is now well known, there were wet (pluvial) periods, alternating with relatively dry ones, and no doubt these vicissitudes had much to do with the extinction of various elements of the fauna and flora. The last of these pluvial periods, near the end of the Pleistocene, seems to be the period of Lake Cahuilla.

We seem to have various evidences of this pluvial period in southern California. The fauna of the tar pits at Los Angeles, including large herbivorous animals, such as elephants and mastodons, could hardly have been supported by such vegetation as now exists in the region. The subfossil land snails on the islands off the coast, especially San Nicolas Island, are so abundant as to suggest abundant vegetation, though it is true that the present denuded condition of the islands is largely due to the grazing of sheep. But Lake Cahuilla itself seems to furnish evidence of a pluvial period of long duration. Such a large shallow lake, supporting an enormous population of mollusks, must have existed for a long period, but it remained strictly fresh water until near the end of its existence, when the marine genus *Acteocina* appeared. This genus is represented, sparingly, by a minute species, which Willett described as new. Now the Salton Sea was formed as recently as 1905, when the Colorado River flooded the Salton Sink, an area below sea level. It is the fresh water which makes the sea salt, as the result of evaporation, and under present climatic conditions the Salton Sea has now become as salt as the ocean. It does not seem possible that Lake Cahuilla could have remained fresh under climatic conditions such as exist today.

More study of Lake Cahuilla is needed, and interesting discoveries may be made. Dr. W. O. Gregg writes that he has found an additional mollusk in the deposit, *Pyrgulopsis nevadensis* (Stearns), and suggests that still others may be found.

T. D. A. Cockerell
Box 411, Palm Springs, California

A Critique of the "Exact" Natural Sciences

The current widespread discussions on the subject of the proposed science legislation have brought forth again the old problem of the "exact" natural sciences and the "inexact" social studies. At the risk of incurring wrath from both sides, I should like to state a view which, unfortunately, has not been generally considered.

The apparent basis for the argument is that the "exact" sciences deal with subjects and materials which are under rigorous experimental control of the investigator, while the "inexact" sciences are mainly concerned with the irrational and, at times, irresponsible activity of a mass of individuals amenable only to a statistical treatment. The apparently rather general acceptance of this state of affairs leads one to consider the actual

merits of such a differentiation; such consideration, it is sad to say, does not lend too much weight to the claims of the former group. At this point, the writer wishes to mention that in all such discussion his arguments have been with the "exact scientists" in a general sort of way and that the following line of argument is based on a long period of work in the "exact" sciences (specifically, organic chemistry). The general examples to be cited are based on general practice in organic chemistry, which is, after all, a fairly representative branch of the natural sciences.

The science of organic chemistry is based essentially on a collection of observations which were made on the behavior of physical entities and agglomerations of these. The materials under observation must be regarded as statistical aggregates of a large number of molecules possessing a variable degree of identity, which is controllable to a certain degree by the manipulations entailed in the preparation of such aggregates. It must be conceded that any of the commonly used methods of purification and separation are essentially statistical methods, which cannot lead to the degree of isolation which can be used to justify the commonly-met statement: "pure compounds." Speaking in the sense of absolute logic I do not believe that anyone is justified in saying that this heap of crystals or that vial of liquid is a collection of identical molecules. There is no fractionating column in existence nor a crystallization technique nor any other physical or chemical method capable of absolute separation of materials in the course of an investigation. Whether one starts with the fundamental natural sources or buys the starting material as a "pure starting material" from a scientific supply house, the problem of separation is ever present. Now, the great bulk of work in the field is done with materials which are purified to the practicable extent and represent aggregates which show the gross variations of one unit or somewhat less in their most commonly used indices of purity: the melting point and the boiling point. Much of the technical work is done on materials with considerable extension of this range. Some work, essentially on standards, has been more exacting, but even here the justification for absolute identity of the aggregate is a matter of concern. Let us say, then, that the bulk of the organic chemistry is based on observations of compounds which are 99–99.8 per cent pure, with the emphasis being perhaps on the first figure. Even in the latter case a mole of such a compound will contain 1.2×10^{21} molecules of other substances which were either picked up en route during the manipulations or remaining from the initial starting material. Now, relatively speaking, this number is small; in the absolute sense it is a very large one. It must be conceded that the work in the field of catalysis shows at times spectacular effects produced by materials which are present in fractional per cent amounts in a given mixture; the effects of biological catalysts are at times even more pronounced. Therefore, is there a justification for the neglect of the presence of such large numbers of molecules as cited above in materials under study in so far as the chemical behavior is concerned? Of course, there is the practical justification which can be carried to the logical conclusion which is that there is no physical apparatus possible (at least in our present state of knowledge) capable of absolute resolution of molecular aggregations. But this is just another way of saying that our "exact" science is not exact; that we do not really *know* that many reactions are or are not initiated by at least some of those miscellaneous molecules which are swarming in our "pure" compounds. These reactions need not be the spectacular ones induced by the well-known catalytic agencies, but merely the "everyday" classical reactions. We see the gross statistical effects only and have little or no true representation of the actual events.

Does not this seem to be similar to the criticism leveled at the "social" scientists? Certainly, there is a striking parallel between the "materials" under study. As a matter of fact, the social sciences, especially in recent years, have devoted much time and effort in dealing with problems induced by relatively small fractions of national population. As an example, a well-known radical party which numbers some 50,000 members, i.e., some 0.03 per cent of our population, has had more words written about it by the "inexact" scientists than have been written by the "exact" organic chemists on the "missing" 1 per cent (or somewhat less) of their materials. On this basis, how much logical separation can we make between the two fields of work?

G. M. KOSOLAPOFF

Monsanto Chemical Company, Dayton

Pandora's Box

The Army and the Navy appear to be determined to go ahead with experimental atomic bombing of naval vessels, despite the grave warnings by some physicists that any uncontrolled release of atomic energy might set off a chain reaction which would detonate the entire earth, and despite the fears of biologists concerning the possible effects of a subsurface explosion of an atomic bomb on marine life. The announced plans to carry out this experiment in the face of these warnings betrays a profound lack of understanding of the force which scientists have placed at the disposal of military men, and a regrettable paucity of imagination and lack of concern for other life on this planet. The chief concern of mankind should be the prevention of any further release of the atomic bomb: Hiroshima and Nagasaki are examples enough of its power, and adequate warning of the shape of things to come, and this unnecessary and dangerous experimental bombing should be abandoned before it is carried any further. Certainly its possible effects, in the light of our present inadequate knowledge, should be called to the attention of every one concerned in this scheme. War is out of date, and even admission of the possibility of future wars is welcoming the premature extinction of mankind. It is already far later than our military minds think it is.

JOEL W. HEDGPETH

Texas Game, Fish and Oyster Commission, Rockport

Book Reviews

The falling sickness: a history of epilepsy from the Greeks to the beginnings of modern neurology. **Owsei Temkin. Baltimore: Johns Hopkins Press, 1945. Pp. xv + 380. (Illustrated.) $4.00.**

This monograph, which is Number IV in the publications of the Institute of the History of Medicine, Johns Hopkins University, traces the history of epilepsy, or the falling sickness, from the ancient Greeks to the point where historical perspective ends and the present debate begins. This latter point is considered to be about 1880, when the impact of Charcot's and Hughlings Jackson's work made itself felt. The author felt that, since he was not a neurologist, he was not qualified to pass judgment on the works of recent decades. His aim is to present the past with a view of helping the reader to understand the setting of the present problem. The evolution of the various ideas concerning epilepsy is traced from the sacred disease in antiquity, the falling sickness in the Middle Ages, to that of more recent times when psychological concepts were discarded and the epileptic phenomena were explained on basis of physiological disturbances in the brain.

Treatment of the disease at the various stages in the evolution of the concepts regarding it is discussed fully from the magic of ancient times to the introduction of the use of bromides by Locock and Wilks in the latter half of the Nineteenth Century.

The book is well documented by over 700 references and there is a good index. Students of the history of medicine and physicians who are interested in the treatment of this important disease, which afflicts nearly one million people in this country, are greatly indebted to Dr. Temkin for his excellent presentation of its background.

H. Houston Merritt

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Engineering preview: an introduction to engineering including the necessary review of science and mathematics. **L. E. Grinter, Harry N. Holmes, H. C. Spencer, Rufus Oldenburger, Charles Harris, R. G. Kloeffler, and V. M. Faires. New York: Macmillan, 1945. Pp. x + 581. $4.50. Home Study Edition: Pp. x + 619. $6.00.**

Intended for junior or senior high school students or college freshmen, this well-written and well-printed work aims to give the reader an insight into engineering, primarily for the purpose of enabling him to decide whether or not to take up engineering as a life work.

Although one may differ with the authors on details of engineering evolution, the first chapter gives the reader a perspective that should be very helpful and is too often lacking. The chapter includes a "parlor test" to determine engineering aptitudes. The logic of including this material in the book rather than in a separate pamphlet may be questioned. If the "home study" reader "flunks" this test and takes the result seriously, he would have no need for the remainder of the book. Likewise, for classroom work, it would seem more logical to take this test before enrolling in the course instead of as a part of it. The reader who passes the test will find much of value in the remainder of the book, including a good refresher course in essential mathematics.

Chemistry is treated in the second chapter of about one hundred pages, and the treatment appears excellent for its intended purpose. After dealing with the nature and importance of chemistry, the chapter deals in a limited way with many phases of its various branches and includes some material that usually is considered as atomic physics.

Although physics is emphasized in the introductory chapter, the work does not include a chapter on that subject. The sixth, seventh, and eighth chapters, however, deal with four of the subdivisions of physics, viz., Light, Electricity, Mechanics, and Thermodynamics, and with the engineering applications of these sciences. Missing are treatments of the nature of light and of sound and hydraulics.

Following the chapter on Chemistry, there is a well-illustrated, hundred-page chapter on Technical Drawing which should be a valuable part of a book which is to serve the intended purpose.

An extensive chapter on Mathematics provides a good introductory course up to, but not including, the calculus. The chapter concludes with work on curve fitting, and nomographs. Over fifty pages of good mathematical tables are placed at the end of the "classroom" edition, but ahead of the two extra chapters in the "home study" edition.

A thorough treatment of the slide rules commonly used by engineers is given in a chapter which follows the one on Mathematics.

The only difference between the "home study" edition and the "classroom" edition of this book is that the former includes, at the end, a chapter on Writing a Technical Report, and one comprising a Comprehensive Examination. This includes a key so that the reader may grade his own accomplishment. The material on technical report writing is very well done and should prove very valuable to the "home study" student.

The reader may be somewhat confused by a statement in the first paragraph of the chapter on Mathematics, which seems to conflict with some carefully drawn distinctions between an engineer and a scientist, given in the early pages of the first chapter. The former statement indicates that a scientist is an engineer who uses mathematics. The distinction drawn in the first paragraph is much better. Also confusing is a statement in the chapter on Technical Drawing which implies that the usual, black-lead drawing pencils produce *colored* lines.

The chapter on Mathematics includes an explanation of the process of finding the lowest common denominator which does not explain. Also, the discussion of "per

nt'' includes the confusing statement: ''The number is 100%.'' As used, this statement is correct *before* e decimal point is shifted, but not *afterward*.

The discussion of slide-rule errors in the chapter on at subject could be improved to bring out more fully e limitations of the commonly used slide rule. The atement that ''slide-rule answers are accurate but not act'' is hardly sufficient. In fact, the authors would ve done well if they had included a brief chapter, ritten in their interesting style, on the usually dry subct of measurement, tolerances, precision, accuracy, and mits-of-error. Such terms as ''exact'' and ''accurate'' ean little in engineering unless carefully defined. No ention is made of calculating machines as used for athematical work in which slide-rule errors would be o large to tolerate.

The abbreviations of terms do not in some cases follow e recommended practice of the American Institute of lectrical Engineers—for example, a-c should be used stead of a.c.

The errors and inconsistencies appear to be few ineed for a first edition, and both books are likely to be opular with many eager students.

I. MELVILLE STEIN

eeds & Northrup Company, Philadelphia

nfrared and Raman spectra of polyatomic molecules. Gerhard Herzberg. New York: D. Van Nostrand, 1945. Pp. xiii + 632. (Illustrated.) $9.50.

This comprehensive treatise constitutes the second of series on molecular spectra by a competent writer and ill be cordially welcomed by all who have a serious nterest in this field. It is, however, primarily a book for the specialist, and for its enjoyment a reasonable previous knowledge of the subject is a prerequisite. The xtent of the material covered and the adequacy with which it has been treated may be judged by the 978 literature references and the complete subject index of 5 pages, which greatly enhance the value of the book s a reference.

The organization of the book is very logical, though possibly at the expense of introducing certain pedagogical difficulties, since the phenomena to be explained and their interest and relation to other knowledge do not become fully evident until the later chapters. In the Introduction a discussion of the symmetry properties of molecules is immediately presented, greatly facilitating the later discussion. Chapters I and II, which deal with Rotation and Rotation Spectra, and Vibrations and Vibrational Energy Levels, respectively, are primarily a theoretical discussion of the arrangement of the energy levels of molecules, of their degeneracy, and of their symmetry properties. The treatment is very complete, and, as in other sections of the book, alternative approaches to a given subject are often presented. In many cases proofs are not given, which occasionally seems unfortunate. For the reader who is not interested in theory for its own sake it may appear that undue

space is devoted to some particulars which will seldom, if ever, be observable by experiment.

It is not until Chapters III and IV that the significance of much of the preceding discussion will become evident to the reader who is not fully conversant with the subject. For many readers the main value of the book will lie in these chapters. In Chapter III, after an introduction to Vibrational Infrared and Raman Spectra, an exhaustive and critical review is given of existing data on all molecules up to the twelve-atomic. The unsatisfactory condition of certain analyses is pointed out, and this section should prove stimulating in its suggestions for future work. Chapter IV deals with the Interaction of Rotation and Vibration and is adequately illustrated by representative examples of vibration-rotation spectra. The collections of molecular constants obtained from rotational analyses will be useful for reference. Chapter V, which concludes the book, deals with the applications of molecular spectroscopy and is comparatively brief. It may prove somewhat disappointing to certain readers. Had it been more comprehensive, the need for the book itself would have been more evident.

The scope of the book and its possible relation to future applications of spectroscopy is naturally restricted by the fact that it deals with molecules of a limited size, for which a more or less complete analysis of the spectrum can be anticipated. This is illustrated by the fact that the most significant spectroscopic investigations on intramolecular hydrogen bonding have not been mentioned, and that other qualitative, though important, applications of spectroscopy have not been covered.

It is unfortunate that it was necessary to print this book in a type which is at best too small and, in very considerable sections, so small as to be a very severe strain on the eyes.

RICHARD M. BADGER

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California Institute of Technology, Pasadena

Uranium and atomic power. Jack De Ment and H. C. Dake. Brooklyn: Chemical Publishing Co., 1945. Pp. x + 343. $4.00.

The uranium atom, possessing as it does extraordinary chemical as well as nuclear properties, is a difficult subject for a book. The usual procedure is to stress either the ordinary chemical properties of such an element or its nuclear or radioactive properties, but not both. The present volume does not deviate in this regard. It is far more concerned with the chemical properties of the element than with the properties of its nuclei, though it pays extended attention to some of the more recent and spectacular results. One finds a considerable increase in emphasis on the atomic energy in contrasting this second edition with the first edition, which is understandable.

As a chemical treatise, this volume is extraordinary. It reports in some detail a considerable number of facts about uranium and uranium ores which are normally omitted in standard reference volumes. For this reason, it has some real interest. On the other hand, the chemistry is rather incomplete and unsystematic. No serious attempt is made to correlate the properties of uranium with the neighboring elements of the periodic table, and great stress is laid on certain less fundamental properties such as the fluorescence of uranium salts.

On the whole, this volume is a sort of collection of bits of information about the ordinary chemical and mineralogical properties of uranium compounds, with a considerable amount of rather heterogeneous writing about the more spectacular nuclear properties of the element. The title of the volume is misleading, because little of an authoritative nature is said about atomic power.

W. F. LIBBY

Institute for Nuclear Studies, University of Chicago

Kilgore-Magnuson Bill

(*Continued from p. 230*)

DEFINITIONS

SEC. 12. As used in this Act—

(a) "Research and development" means theoretical analysis, exploration, and experimentation in any field of science (including but not limited to the mathematical, physical, biological, medical, engineering, and social sciences), and the extension of investigative findings and theories of a scientific or technical nature into practical application, including the experimental production and testing of models and processes.

(b) "Federally financed research and development" means research and development conducted directly by the Federal Government and all other research and development financed in whole or in part directly by the Federal Government from funds designated for research and development, under a contract, grant, or other direct form of financial assistance for research and development.

(c) "Government agency" includes departments, independent agencies and commissions, corporations, and other instrumentalities of the Federal Government.

(d' "Organizations includes State and Local government agencies, corporations, partnerships, nonprofit institutions, and individuals.

(e) "Scholarships and fellowships" means stipends covering tuition and other fees, and such living, travel, and other expenses as the Administrator may determine.

Scanning Science—

At a meeting of the New York Section of the American Chemical Society it was announced that several steel and iron companies in this country have already established very complete micrographic laboratories, where in three hours an accurate determination of the condition of any specimen of the daily output may be secured.

—*7 February 1896*